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THE CULTURE OF THE BEET, AND MANUFACTURE OF BEET SUGAR,

BY

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PREFACE.

This little work is the result of the observations, study and experience of three years. The first half of that period was passed in the Sugar Factories of France, Belgium and Germany, and in intercourse with cultivators and manufacturers distinguished for science and success. The last half was spent in forming an experimental establishment, and making Sugar at Northampton in Massachusetts.

In consequence of these facts, numerous inquiries have been addressed to the writer on the subject of Beet Sugar, which could not conveniently be answered in any other form than the present. It is supposed that information, which has been sought by many, may be acceptable to more.

The design of this treatise is to bring together in as small a compass as is compatible with clearness and precision, all that seems essential to enlighten the judgment, and direct the measures of American farmers in relation to this new and pleasant branch of rural economy.

In pursuing this design, we propose to treat: *first*, of the Culture of the Beet; *secondly*, of the Manufacture of Beet Sugar; and, *lastly*, of the History and Prospects of this Business.

Northampton, Nov. 26th, 1839.

PART I.

CULTURE OF THE BEET.

§ 1.

SPECIES AND VARIETIES.

THE following are the principal ones cultivated in France.

1. *Mangel Wurtzel* or *Scarcity Root*. It has large, thick succulent leaves; the root is white within and without; grows much out of the ground, and attains a size superior to all other species. Many cultivators have remarked that though it is very good for fattening cattle, it is not equally favorable to the production of milk.

The variety cultivated in England has a reddish or whitish red root. It is not much valued for domestic use, although the leaves are considered good to boil as spinach, and the leaf-stalks and midrib to stew and eat as asparagus. *Dr. Lettsom* states that on his land, which was not propitious to its growth, it weighed, on an average, full ten pounds, and the leaves half as much, so that the whole produce was fifteen pounds of nutritious aliment to every square of eighteen inches.

2. *Red* or *Blood Beet*. It has a long, red, eatable root, and darkish red or purple leaves. Sown at suitable distances, much greater of course than are ordinarily allowed

it in our gardens, it becomes nearly as productive as the sugar beet. The larger the roots grow, the tenderer they are, and the deeper their color, the more they are esteemed.

The varieties of this species are the common red beet, the early turnip-rooted beet, the green-leaved red beet, and the yellow-rooted red beet.

3. *Yellow Beet.* It has yellow, or greenish yellow leaves and yellow roots, which are frequently very long and large. It has been cultivated for making sugar, but most manufacturers have discarded it, finding that its juice, though next in richness to that of the sugar beet, contained from one eighth to one quarter less saccharine matter, than the latter. It is prone to degenerate. A field sown with genuine seed will sometimes yield a fifth, sixth or greater part with a coat of a rose color and flesh white, or coat yellow and flesh white. A single seed will occasionally produce three yellow beets, and one rose colored; though what is commonly called one seed, does in fact contain from one to five seeds.

4. *White Silesian* or *Sugar Beet.* It has pale green leaves, the root pear-shaped, and shorter than the other species. It grows entirely within the ground, except it meet with some obstruction, in which case the exposed part becomes green, and looses a portion of its sugar.

There is one variety of this species, the red-vein-leaved, with rose-colored rings in the flesh. This is considered a degeneracy.

In Germany, besides the yellow and sugar beets, they cultivate principally the following, which appear to be varieties of the mangel wurtzel, or as it is sometimes called, the *great German beet.*

1. *Red* and *White.* It is usually red and white within and without. This beet grows seventeen or eighteen inches long, of which one foot is above ground; and it sometimes weighs twenty-five pounds. Its juice is very watery, and in proportion to its size it contains the least nutritive substance.

2. *Yellow* and *White.* It grows half out of the ground. It is rather smaller and less woody and aqueous,

keeps better and is more nutritive than the preceding. It sometimes weighs twenty pounds.

3. *Pale-red.* It penetrates the earth more than the others, and weighs as much as sixteen pounds.

There is no limit to the varieties of the beet. They may increase like the crosses of sheep. This will always be the case, if different sorts for seed are not set at a good distance apart. Soil and climate have sometimes the same effect. Some fields will produce only the red-vein leaved, although none but seed of the pure white Silesian beet, was sown.

It is supposed by some that the wild *sea beet,* so called, is the parent of all our cultivated beets. It is a native of Holland and Great Britain on the sea-coast and salt marshes. It is found about Nottingham in England. The first beet planted in France, was however, a native of the southern and maritime regions of Europe, and was brought from Italy. The Romans were acquainted with the white beet, which they called *cicla, sicula* or Sicilian.

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§ 3.

USES OF THE BEET.

Although the beet has become so interesting as a source of sugar, it has been scarcely less so for half a century in Europe as food for domestic animals. In France, extensive as the cultivation is for manufacturing sugar, it is still greater for forage. It is particularly valuable for milch cows, improving their milk both in quantity and quality, and imparting a richer color and finer flavor to the butter. This effect is not diminished in winter, nor on the approach of calving.

A cow requires eighteen pounds of sliced or mashed beet per day, with a sufficient quantity of good hay. Swine, sheep, bullocks, and, in some districts, horses also are fed upon the raw root; but for swine it is considered preferable to boil it.

Hitherto the mangel wurtzel has been generally cultivated for feeding cattle on account of its superior volume; but the white Silesian beet is beginning every where to be recognised as the most profitable for this purpose as well as for making sugar. Beets designed for animals, may have their lower leaves removed, and fed out during two or three months, say, August, September and the first half of October.

The beet, besides furnishing sugar, is also used for making *coffee, beer, brandy, spirits of wine, potash* and *paper*. There are establishments on the continent and in England, where these respective products are obtained in abundance from this remarkable root. Recently it has been reported that the French are making wine of the beet-juice.

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§ 2.

THE WHITE SILESIAN, OR SUGAR BEET.

It was found by the first manufacturer of beet sugar, after amply experimenting on all sorts, that this contained the most saccharine matter. Subsequent experience has constantly confirmed this result. With equal culture, its juice is found to be 1° to 3°, *ie.* from 12 to 40 per cent. richer than that of the other species. Taking 7° as the average density, by saccharometer, of the juice of the sugar beet, then the other species will disclose 6°, 5° or 4°; and yield most usually three quarters, two thirds or only half as much sugar. Some allowance however is to be made for the greater abundance of juice in the weaker sorts. But this is not the only reason of the preference. The juice of the sugar beet is least degraded by impurities, which are to be separated before sugar can be obtained in a large quantity or a good state. A further reason is, that it keeps better, in consequence of the firmness of its texture, and the richness of its juice.

§ 4.

CLIMATE.

It has been supposed by some that a northern climate is the only suitable, and perhaps possible one for the production of beet sugar. This impression appears to have been derived from the fact that many of the establishments, and especially the early ones, of the South of France miscarried. Mr. Dombasle, in accounting for the immense increase of sugar works in the North, and their rarity in the South, says it was because agriculture, and the growing of the beet were better understood in the northern departments, or old *French Flanders*. This was the first cause, but this created others. Engineers, machinists, and mechanics, connected with the business, and experienced sugar-makers, would be found where they could find employment; and a sugar factory, besides incurring little or no risk of failure, would get into regular operation a great deal sooner in the midst of the sources of information, and of the means of assistance, than it could in a department remote from them. He does not even allude to climate as of any importance in the case. Nevertheless it grew into a dogma that the business could not be carried on south of 45° north latitude. This opinion was warmly contested by the editor of the *Manufacturer and Refiner's Manual*, in 1833, and is now rapidly giving ground to facts and maturer reflection. This editor pronounces it both incorrect and anti-scientific; for in the first place all plants are found to be richer in oleaginous, aromatic and saccharine properties, the further we go towards the equator; and in the second place, that the beet did not depart from this law, he knows by having experimented upon samples raised at Perpignan, and other places in the extreme South. Humboldt found that the same law applied to different altitudes on the table lands of Mexico. In 1836, eight factories then in activity in the department of Vaucluse and in Languadoc, made 1,131,000 pounds of sugar. These are all situated south of 45°.

The business has been introduced into the kingdom of

Naples, where one of the principal advantages expected, is the production of two crops a year, and the supplying of fresh material from the field, all or nearly all the year round. We are not yet informed of the result of this enterprise, nor of a similar one undertaken in one of the West India Islands, where beet and cane have been placed side by side for a fair race.

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§ 5.

SOIL.

The best soil for the beet is a deep, rich, sandy, alluvial soil, with an open and fair exposition to the sun. But any soil, which will answer for Indian corn, will answer for sugar beet. There is no land except the peaty or mossy upon which it may not be tried with success. Strong, clayey and loamy lands will produce the greatest bulk of beets, if humidity does not too much predominate, but these beets will not necessarily yield a greater quantity of sugar, than a much smaller quantity grown upon an equal extent of light and upland soil. The beet however is not ungrateful for a rich soil. Such an one is undoubtedly to be preferred, for although the juice will not be as rich, yet the superior quantity may be expected to more than make up the deficiency. As a general rule, a soil inclining to sandy is to be preferred. A clayey sand, is better than a sandy clay, provided the subsoil is tolerably retentive. There is danger from excess either of moisture or of dryness. A middling degree of moisture must be sought. The balance, if it incline either way, had better be in favor of the dry, inasmuch as the beet does not require a great deal of moisture except during a few weeks of the spring, when rains are usually frequent and abundant. After that its leaves shade the surface, and prevent rapid exhalation, while its long taproot penetrates the earth and draws up fresh supplies as from a well.

Those who cultivate the beet largely for manufacturing, will do well to sow extensively on both low and upland. If the season prove either wet or dry, one of them will yield well; if it be neither, both may yield well.

Calcareous soils are not unfriendly to the beet. A considerable proportion of the beet growing region of France is of this nature; and very fine crops of beets have been gathered from it, even where there was only three or four inches of vegetable earth, resting on a bed of chalk. This species of soil uses up manure quicker than others.

A gravelly soil is not very good for the beet. The large tap-root, in penetrating the earth to get its food, encounters stones and pebbles, which retard its progress and split it into forks; then, in order that nourishment may be conveyed laterally, radicles, which are of little value, are multiplied. Still it must be admitted that the beet may flourish on gravelly soil; but it would be well to appropriate it to forage rather than to manufacturing. The stones, as far as practicable, should be removed.

Saline soils are to be eschewed, but they are considered favorable for beets designed for feeding and fattening cattle.

Soils too sandy may generally be amended with considerable facility. For the most part they rest upon a clayey bottom, five or six feet below the surface. This may be taken up, pulverized and mixed with great advantage. Clayey marls produce surprising effects on this soil, and favor in an eminent degree the growth and saccharification of the beet. Sandy, like calcareous soils, consume manure too quick.

It follows that stiff, cold, clayey land may be benefited by sand, but it ought to be mixed with lime and stable manure. Calcareous marls are also proper and perhaps preferable.

Calcareous soils of the heavier sort, may be benefited by the application of sandy loam. The lighter sort by clay and clayey marl. Gravelly soils may be improved by clayey loam; peaty soils, by draining, and by the application of coarse earth, common sand, sea sand, chalk and calcareous marl.

In all cases it will be prudent before establishing a beet sugar factory, to try the soil, by raising a quantity of beets, and ascertaining the proportion of sugar they contain. It has been found in several instances after erecting large works, that not a grain of sugar could be obtained by reason of some local peculiarity.

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§ 6.

ROTATION.

Every farmer knows that a piece of mowing, which has ceased to produce grass worth cutting, may yield great potatoes; and that pastures, not worth their fence for feed, may bear superior crops of rye, Indian corn and wheat. This comes of the rotation of crops. Rotation sends to each soil such a messenger as is likely from the known state and disposition of each, to meet with the most favorable reception and obtain the largest contribution; and if an improper messenger should come away empty, or be turned out of doors, it does not follow that there is not wealth in the house. It is stated in a report made in 1837 to the Central Society of Agriculture, in France, that several beet sugar factories in Hungary had been unsuccessful; and that a saline efflorescence manifested itself on the surface of the soil. The reason was that salts of potash and soda are prejudicial to the formation and extraction of sugar. Such lands should be turned to the production of beets for feeding and fattening sheep and cattle, to clover and tobacco crops, until those salts are exhausted.

The following principles are well established.

1. That a naked fallow, or a weeded crop, called also from its taking the place of fallow, a *fallowing* crop, must be the basis of every rotation.

2. That ameliorating or enriching crops, and exhausting or scourging crops should follow one another. Those are called ameliorating crops which are cut or gathered green, such as clover, ray-grass, peas, beans, potatoes, tur-

nips, ruta-baga, cabbages, beets and carrots. Wheat, rye, barley, oats and sugar-cane, are generally considered exhausting crops.

3. That the weeded crop should recur often enough to keep the land clear of weeds. This period cannot often be more than four years.

4. That the manure should be applied to the weeded crop, so that the weeds, of which the manure contains the seeds, may be immediately eradicated, and none suffered to go to seed.

The quadrennial rotation is now recognised in France as the best for the sugar-beet. *Mr. Dombasle* recommends the following:—Wheat, Beets, Barley or Oats, Clover. Where wheat does not enter much into the system of agriculture, as is the case to a considerable extent in New England, a substitute must be found for it. Rye will probably answer the purpose. The following model of a rotation is recommended by *Mr. Brame Chevalier*, a sugar manufacturer and refiner of Lille, and an able writer on the culture of the beet:—Rye, Oats, Potatoes, Beets.

The Editor of the French *Library of Arts and Trades*, proposes this:—Wheat, Clover, Oats or Barley, Beets.

The following has been found by an ingenious cultivator in the South of France to be a successful rotation for that region:—Beet, Wheat or Rye, Clover, Wheat.

There is one *triennial* rotation which is much followed in the North of France:—Oats manured, Beets, Wheat.

Mr. Dubrunfaut, author of the earliest complete treatise on the beet sugar manufacture, considers the beet excellent to precede Wheat, or any other Cereal crop; and on the other hand as a very proper successor of those crops, especially of Rye and Oats. He also recommends Potatoes as a suitable predecessor.

In Europe, Oats, Wheat, Rye or Barley always follows Clover, but Oats is the general favorite for this succession. The editor above-mentioned, proposes winter oats, as leaving the land earlier at liberty to be prepared for the next crop.

Perhaps more extensive rotations may be found better

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adapted to the United States. We are inclined to think that the practice of pasturing so much land as our farmers do, will have a peculiar bearing on the question of a sugar-beet rotation in North America. But this had better be submitted to experience than to speculation. One thing is certain, and in the beginning of the beet culture may be quite important. Grass land of good or middling quality, either pasture or mowing, may be broken up, and beets sown on the fresh furrows, after well pulverizing with the harrow and roller all the earth, that can be disengaged from the roots of the grass. The ploughing must be deep, eight inches at least, and the furrows so laid, as to permit no spires of grass to grow between them. To this effect a heavy rolling immediately after ploughing, may be very useful. The harrow must never cross the furrows. "If it do," said Mr. Dombasle, "you are undone." The rows should also run with the furrows, and then the horse-hoe or cultivator may be used. Compost may be spread upon the sward before it is turned. In this way, and even without manure, very fine sugar-beets, have been obtained both in Europe and the United States.

In Northampton wheat has succeeded beets the present year with rather striking success. A farmer,* let a field abutting on Connecticut river, on shares. On a part of it he raised beets last year, and on the other Indian corn. The whole was equally manured. The corn yielded seventy-five bushels to the acre, and the beets were tolerably weeded. The wheat was harvested, and his share delivered in the barn without any attention to it on his part. In due time a laborer was employed to thrash it. This person, after thrashing a quantity, observed to his employer, that the wheat on one side of the loft thrashed easier, and had a better berry and brighter straw than on the other. Upon examination it was found that the former had been produced upon the beet, and the latter upon the corn section of the field, but with this difference, that the best grew nearest to the river, where it is consid-

* Mr. Hiram Ferry.

ered that wheat is most likely to blast. We had the advantage of examining these wheats, and the difference was clearly such as the thrasher had stated. The proprietor found a difference of three and a half pounds per bushel in the weight. We presume that the difference in the flour would be found much greater, because the grains of the inferior wheat being smallest, it would require more of them to fill a measure, and as the shrunk grains have the same quantity of *skin* as the large, and as it is the skins which make bran, it follows that the superiority remarked would appear still more signally, if the two samples were ground and bolted.

These details seemed to be proper in relation to phenomena, connected with a crop so desirable to our farmers as wheat.

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§ 7.

TILLAGE AND MANURE.

This is by far the most important division under the head of culture. Farmers and gardeners, who are accustomed to raise the beet for the table and stall, and justly regard it as one of the least chanceable fruits of the earth, will probably hear with surprise, that the greatest part of the sugar manufacturers, who have failed in France, owed their fall to bad cultivation. We believe it may be safely said that the manufacturer, who does not either raise his own beets, or stipulate with great exactness for suitable soil, manure, and tillage, cannot prosper. With good and considerate husbandmen, we need not urge this point. They know that a diligent and judicious use of the means of art, will make a world of difference in results even in relation to the most simple and ordinary objects of agricultural industry. But when it comes to a question of manufacturing sugar, and incurring and maintaining a great expenditure, a difference of a ton to the acre in quantity, or of *half* a degree out of *seven* or *eight* of richness in the quality, may settle the fate of an establishment. They have often done so, and will no doubt in hundreds of instances to come.

The number of ploughings must depend upon the nature and state of the soil and of the weather. Mr. Dombasle, being inquired of by us how many ploughings he gave to a certain field, which carried a superb crop of sugar-beets, replied that he gave it *one*, that it ought to have had *four;* but that the season for ploughing was so wet that it could not be done, and he had been obliged to make it up with the horse-hoe, of which he has invented a superior model.

As a general rule, three thorough ploughings are necessary. The land for beets must be mellow. If it be hard and lumpy, it cannot derive fresh fertility from the air, which will not in that case penetrate it, and if it could so derive it, or contained ever so much, it could not impart nourishment to the root. Large tap-roots in these circumstances, fare worse than the fibrous. The latter can in some measure accommodate themselves to the soil; the former must have the soil accommodated to them. If therefore a mellow soil be good for wheat and Indian corn, it is indispensable to the sugar-beet. This is well understood in gardening. The nearer field tillage can be brought to that of the *garden*, the more perfect it will be.

The first ploughing ought to be done in August or the beginning of September, when there will be a thick green growth on clover and other early mowing land; and an abundance of green herbs among the stubble of wheat, oats, barley or rye. These herbs will be a plague, if they remain above ground, but an energetic manure if buried. The stubble, which in the United States is often permitted to vanish, is extremely valuable both in communicating fertility, and maintaining the soil in a light and permeable state. If stubble be on fields seeded down, it ought to be mowed, raked together and transported to the barnyard, or laid up to be used as litter in the stables. Beet-tops, if not used for feeding, ought to be ploughed in. They are considered by some equal to a half, and by others to a quarter manuring.

In these ploughings the furrows should be laid flat. We now have ploughs which perform this operation to great perfection. In case the instrument is defective, it might be well to pass the roller afterwards.

The French usually give two ploughings in the fall, the first at the time we have mentioned, or a little earlier, two or three inches deep; the second about a month after, and ten or twelve inches deep, if the soil will bear it. It is a question which must be determined by experience, whether two fall ploughings will be necessary in this country. The frosts in France are much milder than in any of the farming states of the Union. We therefore have the advantage of that powerful assistant in breaking and pulverizing the arable earth, to a degree, which France can never have.

If fresh stable manure be applied to the sugar-beet crop, it must be done in the fall, between two ploughings, if two are given, and if not, before ploughing. Such manure is excellent, if so applied, but if put on in the spring, it gives roots containing a feeble juice, an inferior quantity of sugar, and that difficult of extraction. Besides, there will be more water to be evaporated, and consequently more fuel to be consumed in the manufacture.

The manure is to be well buried with the plough. In France they have a neat method of executing this process, if the manure be, as usual, long. A boy follows the plough with a fork, and pokes into the last furrow all the strawy stuff, which rests on the next furrow slice. When the plough passes again it is perfectly buried. This is no increase of labor, because the boy would otherwise have to go by the side of the plough to clear the coulter; and then in spite of his efforts it would sometimes be thrown out, and parts of furrows be lost. By pursuing the method we have described, it will run smoothly, and the work will be well and easily executed.

Undoubtedly we lose much of the virtue of our stable manures by exposing them to the sun, air and water. The manure being once buried in the soil, those agents are straightway employed in improving, refining and diffusing them throughout the mass, where the plants will in due time come to claim them.

If manure be applied to the beet crop in spring, it must be thoroughly decomposed, otherwise that degradation of the quality of the beet will ensue. Further, the sugar-beet cannot be produced in its most perfect state, if any manure be applied. The crops combining in the highest degree productiveness and richness, have been raised on land highly manured the preceding year for tobacco crops, which have a powerful tendency to take up salts, and thus to leave the soil in a genial state for the sugar-beet. This then takes its place in the ground, when the manure has become assimilated, and the mass is in the best state to form the delicate cellules, and fill them with white sugar.

Whether one or two ploughings are given in the fall, there must be one at least in the spring. This ought to be deep and *fine*. But every soil will not bear such a depth as we have recommended, nor any thing near it. In some cases, a portion of the sub-soil may be advantageously turned up. This, however, demands a good deal of intelligence and discretion. It may ruin the crop, and for a time the land itself. If the sub-soil cannot safely be invaded, the cultivator must content himself with the surface, such as it is, and let his beets grow partly out of the ground. That portion exposed to the sun and air will not be as rich as that within the earth. This evil may be remedied in a great measure by hilling with a hilling plough or cultivator. Another remedy is to lay the earth in beds, warps, or lands; or to raise high furrows at the last ploughing, and sow upon the summits. By these means the farmer may feel sure of a satisfactory return from a very thin soil.

The sugar-beet will not grow out of the earth unless it is compelled so to do. If it find sufficient depth, fertility and friableness, it will grow twelve or fifteen inches in length, and some experienced cultivators have recommended to plough fifteen inches deep.

After the spring ploughing, a deep and thorough harrowing is to be given; and this is to be repeated, if necessary, until the earth is well pulverized. Rolling after harrowing, is excellent for crushing lumps, and should be used without stint.

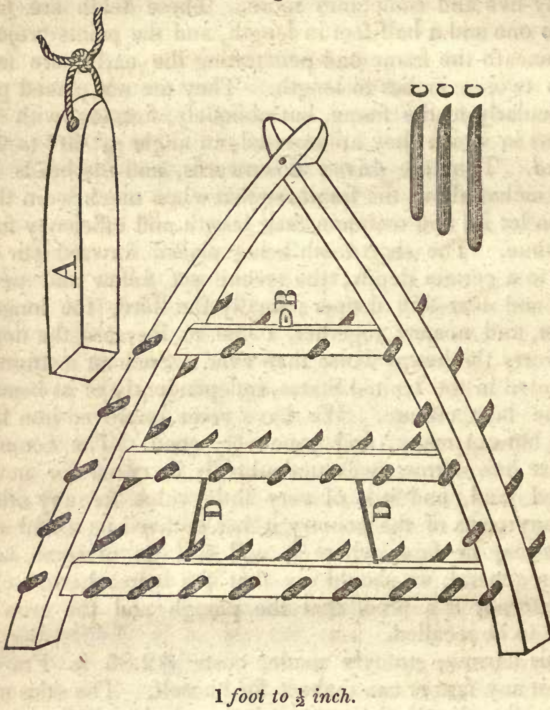
The French have a cheap harrow, which appears to be admirably adapted to the beet culture. It is generally composed entirely of wood. The teeth are set not only in the sides, but also in two or three slats, to the number of twenty-five and sometimes more. These teeth are from one to one and a half feet in length, and the points projecting beneath the frame and penetrating the earth, are from six to twelve inches in length. They are not placed perpendicularly to the frame, but obliquely, forming with the timbers in which they are inserted, an angle of 60° to 70° *behind*. They are driven downwards, and the heads left three inches above the frame, so that when much worn they can be let in, and maintain their length and efficiency for a long time. The short teeth being placed forward stir the earth to a certain depth; the second set follow and penetrate and tear still deeper; finally the third, the longest, largest, and nearest together, come to increase the depth and worry the lumps worse than ever. Such an instrument is wanted in the United States, independently of its bearing on the beet culture. We have some improved iron harrows, but not many, and none very good. The common angular iron harrow was undoubtedly invented for newly cleared land, and it is of very little value for any other. In many parts of the country it has outlived its usefulness. There may be cases where it will still be of some use; but, in general, we should say that if a better harrow cannot enter, it is a proof that the plough and the crowbar ought to be recalled.

This harrow, strongly made, costs $2.85 in France. Almost any farmer can make it for himself. The sides may be straight, though they are most frequently a little curved, as in the figure.

There is another harrow called the *Valcourt* or *Rhomb Harrow*, which is beginning to find favor with the cultivators of the beet. It is spoken of by those who have had experience with it, as unrivalled in the execution of its work. Mr. Dombasle observes that "he did not know how to appreciate the benefit of harrowing until he adopted this model." The teeth are of iron and round. It costs in France $10.

COMMON FRENCH HARROW.

Fig. 1.



1 *foot to ½ inch.*

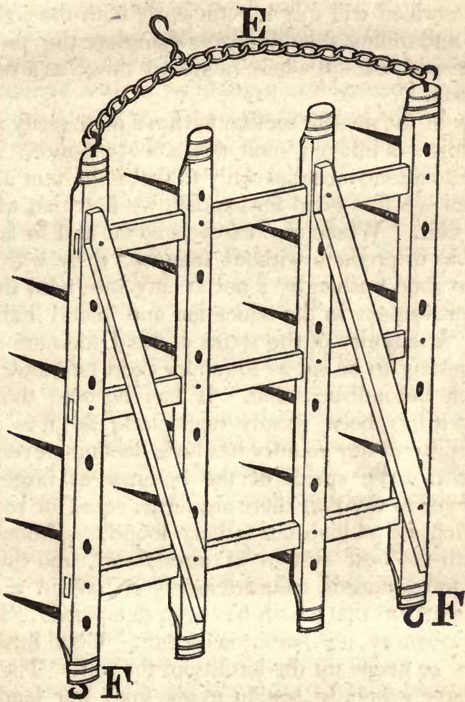
A. Clog, to be attached to the pin, B, and serving, when the harrow is reversed, as a *shoe.*

C. C. C. Wooden teeth, separate from the frame, showing the proportion of the forward, middle and hind teeth.

D. D. Braces of iron or wood.

VALCOURT, OR RHOMB HARROW.

Fig. 2.



1 *foot to* ¾ *inch.*

E. Traction Chain. By attaching the team at different links, the implement divides the soil finer or coarser at pleasure.

F. F. Hooks by which to attach the team, when a gentle operation, as covering seed, is required.

If manure be put upon a beet field in spring, it must be well rotted, and it would be well to screen it. It can be conveniently thrown through a screen in filling it. It may then be spread upon the spring furrows. Such a harrow as we have described will mix it sufficiently with the soil. A harrowing and rolling should always complete the preparation for the seed, except where ridges are raised as a remedy for a thin soil.

Thus far in the present section we have necessarily mixed with the subject of tillage a good deal about manure. But it is now time to attend more specially to that important matter.

Wherever we find good husbandry, we find that manure is the soul of it. Where the earth is so fat and so favored by climate as to produce without manure, there will never perhaps, be good husbandry ; not at any rate until there is a great improvement in the education and moral habits of mankind. A majority of the states of this Union are so situated, or getting to be so, as to render good husbandry not only possible but indispensable. It has become the more so, because it has been greatly neglected ; for it is a fact that the fertility of our country has been declining ever since its settlement. We speak of the country at large, and it is no answer to say that there are farms equal or superior to the maiden soil, which our fathers found. Probably a century with the best system of agriculture, and the best disposition to execute it, could scarcely restore an amount of fertility equal to that which has been dissipated. This is not good husbandry, it is barbarous waste. Good husbandry increases or keeps up the fertility of the soil. The truth is that we have generally sought to get from our lands the most that we possibly could, in the shortest possible time. In this as in other things, haste makes waste. We kill the goose that lays the golden eggs.

The preparation and use of manure is therefore a subject of deep concernment to the farming interest generally, but to the sugar-beet cultivator it is more especially so. We do not mean to intimate that other crops can better dispense with it, but only that the application of it to the sugar-beet crop, is a matter of more than ordinary delicacy and importance.

The manure best adapted to the beet, with one or two small exceptions, of which we shall speak, is the ordure of horned cattle. This is particularly suited to sandy soils, supplying in a measure by its viscous and tenacious properties, the natural want of compactness in such soils. Next to this, horse, sheep and hog dung may be used, but they are of too hot a nature to do the greatest good on sandy soils, unless mixed with other matters, and formed into a compost. These manures, however, are most excellent for moist, clayey and loamy soils, and there they ought always to be bestowed. The liquid manure of the stables ought to be carefully conducted into a general reservoir, where it is preserved for clover and grass land, or to be distributed among the beets in case of severe drought. At the same time that it relieves this, it gives a surprising impulse to the growth of the plant. It must be confessed that it tends to make it watery, and we would restrict its use to the case of drought.

Lime is not contrary to the nature of the beet. If used, it must be mixed with treble the quantity of vegetable mold, or street sweepings, or scourings of ditches, ponds and stagnant pools. The mass should be mixed with a shovel and stirred once a month until the lime is completely slacked. The compost thus prepared, may be spread upon the spring furrows and harrowed in.

But the most stimulating and at the same time innocent manures, which can be used for the beet, are the refuse of the sugar-house. These consist of scums and sediment from the pans, and of animal charcoal, or bone black in powder, which has been used in clarifying.

This powder is mixed, equal parts, with pulverized and sifted earth. In this state it is thrown with the hand in the manner of broadcast sowing, at the rate of ten to twenty bushels of charcoal to the acre. It may, perhaps more advantageously, be deposited in drills or holes with the seed, or distributed like ashes among the plants. Some horse drilling machines carry and deposite powdered manure with the seed. It may also be put in the holes, pricked for transplanting beets, around the root of each plant before the loose earth is pressed home. A child can perform this ser vice. In either of these ways it animates vegetation in an extraordinary manner without any injury to the saccharine richness of the plant. One of the benefits of this manure is, that it imparts such vigor to the infant growth of the plant as to put it promptly beyond the reach of insects, disease and drought. But its efficacy is not spent in the outset, but continues unabated during the entire season, with this signal advantage over almost every other manure, that it never harbors the seed of parasite plants, which may subsequently exhaust its own strength, nor the eggs of insects which may devour the plant it is designed to nourish.

This manure is almost equally beneficial to every kind of soil. The only difference is that three or four bushels more to the acre are to be put upon strong than upon light lands. Its deep black enables it to absorb and accumulate heat to an uncommon degree ; hence its more than usual activity in clayey, cold and humid soils. On the other hand its antiseptic property retards in a ratio happily adjusted to the increasing demands of the young plants, the decomposition of manures on sandy and calcarious soils ; and thus corrects the tendency of those soils to devour their food too hastily. And while it effects these objects, it is all the time administering directly a copious supply of carbonic acid, one of the most important articles of sustenance to the vegetable creation.

This manure has the most pleasing effect upon lawns, carpets, borders, and gardens generally, producing a swift and wholesome growth, and embellishing them with a depth and beauty of coloring, which contrasts finely with the pale gravel or sand of the alleys.

This precious manure was unknown until 1822. Previously to that time many millions of pounds had been annually thrown into the public discharges. It had been used for a number of years, as it still is, though not so much in powder, for clarifying juice, liquor, and syrups, both in the manufacture and refining of sugar. In that year *Mr. Payen*, a distinguished manufacturer, refiner and chemist, at Paris, suggested the idea of its value as manure. Experiments were immediately made in various parts of France with striking results. At first it sold for two francs the hectolitre, about sixteen cents a bushel, but soon rose to seven francs the hectolitre. It is now manufactured at a large establishment near Paris, expressly for manure, and the calcination bein managed with exclusive reference to this object, more of the animal and stimulating matters are retained.

The scums and sediments of the sugar-house having been dried, reduced to powder, and mixed, equal parts, with earth, may be applied in the same manner as animal charcoal. These scums and sediments are the residuums of the defecation, or first clarification of the beet juice. They consist of a number of compound substances, in which lime occupies the first place.

The finest effects of these manures are undoubtedly produced on strong loams, but the farmer need not hesitate to give them in proper doses to any sort of soil.

Animal manures, such as blood, flesh, fish, ground bones, and night soil, are the most stimulating of all; but the sugar-beet cultivator who aims at a good quantity and quality of sugar, rather than a great bulk of beets, will abstain from them. Fields manured with ground bones and night soil have been known to yield forty-five tons to the acre; but exceedingly aqueous, giving not more than half the due proportion of sugar, and that difficult of extraction. If the animal manures are admitted at all in the cultivation of the sugar-beet, it should be only on stiff, cold soils, in moderate quantities, mixed, if possible, with animal charcoal, which allays the violence of their decomposition.

Plaster of Paris is good for beets. Street sweepings, the scouring of ditches and the slime of standing water, treated with lime as already described, make a manure very grateful to the beet. Ashes are generally to be avoided; they make growth, but they also form salts of potash, in lieu of sugar. Nor is this their only or perhaps worst effect. Besides preventing a natural and plentiful formation of sugar, they are very liable to injure, in the processes of manufacture, that which is formed.

§ 8.

SOWING.

The practice is now almost universal to sow in rows, and in the place where the plants are to remain.

The first step is to determine the distances which the rows and roots shall occupy. These vary according to the rent of land, the wages of labor, the nature of the soil, and the circumstances and habits of the cultivators. If beets are to be hoed and weeded wholly by hand, one square foot is deemed sufficient for each plant. This gives forty-three thousand five hundred and sixty plants to the acre. Small cultivators, who wish to economize to the utmost their ground, and have not working animals, adopt this distance. But on a large scale it is seldom done. In France the distance of the rows is commonly 18 to 20 French inches, equal to 19 to 21⅓ inches English. They sometimes go to the extent of 25 to 30 inches. The smallest of these intervals will admit the horse-hoe, as we shall hereafter more particularly explain. The distance of the roots in the rows is most generally 8 inches.

Only one plant must stand in a place. At the rate of 8 inches between the plants, and 18 inches between the rows, the French still preserve the space of one square foot to each plant. In Germany the distance of the rows is the same as in France, but they leave 15 inches between the plants. This probably arises from their habit of cultivating the largest species. In a country where land is cheap and labor dear, 2½ feet between the rows, and 8, 10 or 12 inches between the plants, will be found the most convenient and profitable. With such intervals, the plough, horse-hoe, or cultivator can pass without fear of injury, between the rows, and the hand-hoe betwixt the plants. There will then be nothing for the fingers, except the weeds directly round the plants. The following table shows the number of beets which an acre will bear, the rows and plants being placed at various distances.

Rows.	Plants.	Number of Plants per acre.
18 in.	8 in.	43,560
20 "	" "	39,204
24 "	" "	32,664
30 "	" "	26,136
30 "	10 "	20,908
30 "	12 "	17,424

These last intervals may at first view appear unnecessarily large. It must however be considered, that a sugar-beet root of medium size, is three or four inches in diameter, and that the top, if permitted to expand in freedom, will be two feet in diameter. The tops will bear a mutual compression, and to this they must submit in the direction of the rows, though placed at the greatest distance we have recommended. But if confined that way, they will expand with the more force over the space between the rows, and starve out the weeds that may rise after the last hoeing.

The preference we have expressed for ample spacing, has reference only to horse-hoeing. If the beet sugar business should take root and flourish in America, it will undoubtedly be advantageous to the proprietors of one or two acre lots, such as mechanics and day laborers in this country may generally own, to plant one foot apart in every direction, and employ children before and after school in weeding them. Half an acre, enriched by the ordure and litter of the cow-house and pig-stye, soap-suds, and the wash of the sink, which commonly creates a nuisance, would yield eight or ten tons. The weeding could all be done by two little children before and after school, and the value would be twenty-five to thirty dollars, the interest of four or five hundred dollars. Besides this, a great deal of excellent feed would be made for the cow and pig.

It is a point of the greatest importance to procure seed that is not too old; for although it retains its germinating power seven years, yet it comes tardily, and gives a degenerate root after three or four years. Good fresh seed is heavy, and of a whitish yellow, slightly tinged with green. Old seed is recognised by its deeper yellow. Plunged into tepid water, the worthless seeds assume a clear brown, and when opened, the kernels appear blackened; whereas the sound seed presents in the interior two or three white points.

Some think the seed ought to be committed to the ground in its natural state; others are of opinion that some preparation is useful, especially for sowing the second time. In France they generally plunge the seed in water, or lime-water blood warm, or they sprinkle it until a handful compressed, moistens the hand. They then lay it in heaps six inches in depth, until it is near sprouting. Mr. Crespel Delisse soaks it in hot water, and dries by mixing with it powdered lime.

It is difficult to sow the beet with uniformity, unless it be done with the fingers, on account of the jaggedness of the seed. Powdered lime, used as above-mentioned, is in some degree a remedy; but in this case the seed must be passed through a sieve or cullender to separate those which adhere together. Another and better remedy is to beat or grind the seed gently in a wooden mortar, and winnow it. The operation is to be repeated, until the seed is deprived of its asperities, and is capable of falling freely through the tube of a small tunnel. It loses by this operation one third of its weight. This manipulation will be peculiarly important in the United States, where the hand and horse-drill will probably be much used, and the free and regular transmission of the seed from the hopper to its place in the earth, will be essential to the success of the crop. We have not yet seen a field in the United States sown with a drill, which had not many and wide vacancies in every row. Our farmers think that labor is too dear to be expended in transplanting. There is therefore the more need of good seeding. We shall describe various methods of sowing, because farmers, who are not provided with the most convenient implements, have complained of the sowing as a heavy labor.

An instrument, called in France a *rayonneur*, and which we shall call a *furrower*, may be formed thus. Take a piece of oak, or large pine scantling, or any straight timber of a size, which would answer for the stock of a bush-harrow; insert in it three or more wooden teeth at such distances as are desired between the rows of beets, and projecting four inches. In the centre, and perpendicularly to the teeth, insert a handle like that of a rake, bracing it, if necessary, on each side. This is for the hand. If a horse is to be used, insert a pair of long fills. This instrument, if well guided, will trace accurate lines one or two inches deep, over an acre of ground in an hour. Drawn by a horse, and in that case being so made as to take a wider sweep, it will execute the same work in less than half an hour. Men, women or children may follow, depositing the seed.

In France they commonly put one seed to every four inches, expecting that half will perish either in the seed or the plant. If the seed be good, cleaned and purified in the manner we shall describe in treating of raising the seed, we should not be afraid to risk a single seed at the distance intended for the plant. The seed may be covered by enverting a harrow and passing it over the surface, or with a roller, if the ground has not been much rolled previously to sowing.

Another method of sowing in rows, is to stretch a cord, and make a drill with a hoe-handle or a stake. This will take about six times as long as the hand-furrower. In Germany they have a method, which answers very well if there be many hands. A small cord forty to fifty feet in length is tied into knots at such distances as the plants are to stand. Each end is attached to a stake. Two men seize the stakes, haul the cord taught, and plant them in the earth, where the first row is to run. On the outside of the cord, and facing the field, men, women and children take their stations, each provided in a bag or apron with seed. Each of them takes charge of as many knots as he can reach without getting out of position. As soon as the stakes are planted, he deposits a seed before every knot within his division. Meantime the stake-men apply to the surface of the ground small batoons, which they carry in their hands, and measure the distance at which the stakes are to be placed next. By the time this is done, the first row is planted and covered. The stakes are then removed, planted anew, and the former operation repeated. Two men and a dozen women and children can sow three acres in a day.

Many cultivators sow with a dibble. One man can make as many holes as several women and children can fill. This affords the opportunity of putting a little powdered manure, mixed with earth, atop of the seed. On withdrawing the instrument, the earth falls back so as to leave the holes not too deep. The general rule is one inch for clayey land and two or three inches for light. In the south of France this method has been happily modified, so as to ward off the danger of drought. There the surface of the earth may get so indurated before the tender germ appears, that it cannot pierce it. Sand thrown into the holes as a covering of the seeds, is a complete remedy.

On light lands the French sometimes sow with the plough, but in this case it will not do to strike a furrow more than three inches deep. A woman or child follows the first furrow, placing the seeds at the desired distances. The next furrow covers them, and when enough furrows are turned to form the space between the rows, more seed is deposited. A man, a woman or child, and horse, can sow an acre and a half a day.

In Bohemia they apply this method on a great scale in a peculiar manner. Two or three ploughs follow one another. Sixteen or twenty men arranged in pairs along the line of the furrows, thrust the seed with three fingers into the ridge of the last furrow; the first one of each pair doing it at the distance of twelve inches and to the depth of two inches. His second follows, and inserts a seed to the depth of one inch between every two already planted. If the weather be wet, the last will come up; if it be dry, the first. If the earth be lumpy the seeds are placed in the slope of the furrow. This method is attended with the advantage of always placing the seed in fresh moist earth.

We have now described the methods of sowing, which are considered most sure, but we have not yet mentioned that which is most used, viz.; that of the *horse-drill*.

There is a variety of this sort of machines. Some of them make the drills, deposit the seed, drop some powdered manure with it, and cover the whole; and most of them perform all these operations except the third. They execute their work with such rapidity that a man, boy and horse can sow ten acres in a day. Hughes's horse-drill appears to be most approved in France. Mr. *Edward Church* in his useful *Notice of Beet Sugar*, highly commends Hill's.

These machines are provided with handles which are held by a man, while the horse is guided by a boy. It requires vigilance and tact on the part of the man. The hoppers or capsules are liable to get empty; and the tubes, which deliver the seed into the furrow, to get clogged with dirt, especially if the ground be moist. In either case a row, or part of a row remains without seed, and what is worse, it cannot be ascertained where the deficiency begins, until the seed comes up.

These horse-drills will serve equally well for Indian corn, wheat, turnips, mulberry, ruta-baga, &c. The horse-drill of Mr. Crespel Delisse has been highly recommended in this country, but it is not approved by the farmers of France. They object to it that it does not deliver the seed well in ascending a rising ground, so that such portions of the field are always badly sown.

The *barrow-drill*, called in the United States the planter or seed-sower, is also used in France. It will answer for a limited cultivation.

Rollers have been invented in France, which facilitate the sowing. *One* of these, six feet in length, is armed with nipples, which make rows three feet apart, and holes fourteen inches apart. Women and children follow and deposit seed, and powdered manure in the holes. *Another* is formed of stout staves fixed on cast-iron hoops and wooden heads. Holes are made in these hoops and in the staves at various distances. Nipples are attached by means of these holes so as to make the distances both of plants and rows, such as the nature of the soil, and other circumstances may render convenient. It is considered that in light and dry soils the rows should be nearer, than in moist and stiff, in order that the entire surface may be sooner covered by the leaves. This last roller distributes powdered manure, which being thrown inside, passes the holes and is lodged in or near the place of the future plant.

A pound of beet seed contains about 20,000 seeds. Of course if the seed be good, two pounds will be enough to sow an acre. But it is better not to spare the seed, not at least until the cultivator raises, cleans and cures it himself, and feels perfectly sure of its quality. Seed ought to be procured and tried in a box in winter.

The time for sowing begins the last days of April, and continues until the first days of June. If the crop be for manufacturing there ought to be a succession of sowings from week to week during that period. If it be for feeding, the first of June is early enough. It is true that in France they generally sow a month earlier, but experience has convinced us that earlier will not do for our climate, except that we wish to take up the beets by the first of August, in order at that time to commence the manufacture, which will be an important advantage. Seed may be sown in autumn, and we have had a little sown at that time, which did extremely well.

The French sometimes sow beets broadcast, and this in the beginning was general; but it is now for the most part repudiated. They also, to a small extent, sow in nurseries, and transplant. Very fine crops of beets can be raised in this manner, if proper pains be taken, and it is an excellent way of supplying a garden or a small field from the superfluous plants of a neighbor, when one's own seed has failed. If nursery planting should be tried, the seed ought to be sown in a good garden with a southern aspect, two inches apart, in the month of April, and transplanted before the middle of June. There is the advantage in this way of destroying the first irruption of weeds with the plough. The plants are set out when they are as large as a little finger. They are commonly dotted in with a dibble, and a little powdered manure put around the root by a child.

If the weather be dry beet seed will lie in the ground some weeks without germinating. In this case the farmer must have patience. Sowing again would not help him. When rain comes, the seed will come, and a second seeding would do no more.

It is better to seed so thick as to have many plants to pull up, than to do it so thin as to have a few to set out. We have used twelve pounds of seed to the acre, but then it was broadcast, or with a barrow-drill, poorly contrived for this seed. In France they use eight or ten pounds to the acre.

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§ 9.

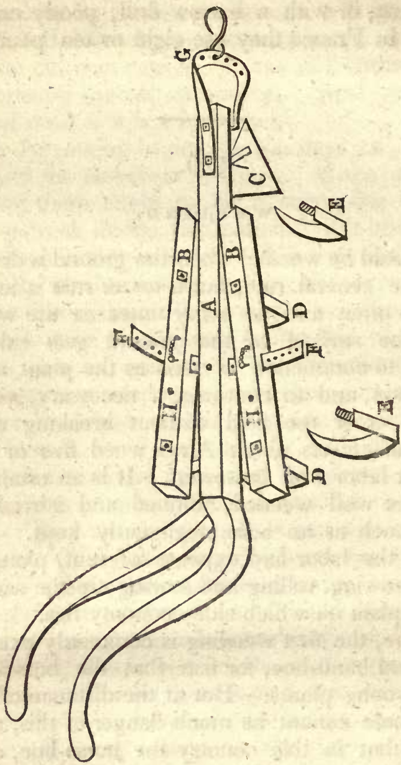
WEEDING.

Beets should be weeded when the ground is dry. Three times is the general rule, but a better rule is to weed and hoe just as often and as many times as the weeds make head, or the surface of the ground gets caked. The weeding is to commence as soon as the plant shows four or five leaves, and to continue, if necessary, as long as a person can enter the field without breaking the leaves. Good manufacturers about Arras weed five or six times, and think it labor well bestowed. It is an established fact that an acre well weeded, thinned and stirred, produces twice as much as an acre negligently kept. When we reflect that the labor and expense of rent, ploughing, manuring, harrowing, rolling and sowing are the same in both cases, it is plain on which side economy lies.

In France, the first weeding is commonly executed with the hand and hand-hoe, for fear that the horse-hoe would injure the young plants. But at the distance of two and a half feet, there cannot be much danger of this, and we are persuaded that in this country the horse-hoe, and in the absence of that, the cultivator may be used with great advantage at every weeding except perhaps the last, when it might break the leaves. The horse-hoe is incomparably the best. Mr. Dombasle has invented an admirable one which, among other advantages, has that of going close to the rows without danger of injury to them. It also lifts and stirs the earth effectually, and makes clean work of the weeds. It opens and contracts so as to work between rows eighteen to thirty inches apart.

ROVILLE HORSE-HOE.

Fig. 3.



1 *foot to ½ inch.*

A. Beam.
B. B. Side bars.
C. Triangular Steel Share.
D. D. Hookshares, entering the earth as a scythe enters grass.
E. E. The same, separate from the frame.
F. F. Rack.
G. Regulator.
H. H. Extra holes to which hookshares may be shifted, when by the contraction of the instrument, they would interfere with one another.

It should be borne in mind that cleaning the field, though the first, is not the only object of weeding beets. The earth, particularly where the soil is strong, is apt to become indurated. In that case the horse-hoe is eminently serviceable. It enters and pulverizes, where the hand-hoe might rap long without getting admission. In case of drought it becomes more than ever needful to stir the earth though there be no weeds upon it. It opens it to the dews and to the air, charged with vapor, just in proportion to the intensity of the drought.

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§ 10

DIGGING.

The beet ripens earlier in the United States than in France. The summer heat is more intense, and the development of the plant is proportionably accelerated. At Northampton beets sown the first of June this year, were perfectly ripe on the first of September, and some of them were beginning to put forth new leaves. The period of their growth and maturity is never estimated in France at less than four months. Last year, 1838, beets sown the first of May, dropt their leaves entirely about the first of August, and soon after were crowned with an entire new set of leaves. On the 30th of August we procured a quantity of these beets for the purpose of ascertaining the effects accompanying these phenomena. The roots, having been cut across the grain, presented a remarkable appearance. Between the layers of the elongated cellular tissue, *i. e.* in the rich and pulpy parts of the root, there was a reddish brown color, resembling that which a crushed apple acquires after a short exposure to the air. The diffusion of this discoloration throughout the concentric strata, containing the vesicles of the sugar, reminded us of the appearance of clefts of a rock, into which gunpowder has been flashed. These beets had lost their savor. They had an insipidity approaching to that of chips. Having carefully dried the slices, reduced them to powder and extracted the soluble matter, we found that they did not contain an atom of crystallizable sugar, but yielded only a syrup of a dull and disagreeable taste, with scarcely a trace of saccharine. A case resembling this in effect, though it is not stated that there was a second set of leaves, is given by Chaptel, and is copied into most of the books on the beet sugar culture. The substance of it is, that in the Department of Landes in the extreme south of France, a gentleman, being about to start a beet sugar factory, experimented on his beets every eight days from the first of July to the last of August, and constantly obtained three to four per cent. of good sugar. Feeling now sure of his crop, he discontinued his experiments, and devoted himself exclusively to the completion of his sugar-house and apparatus. But what was his astonishment and dismay, when on recurring to his beets towards the end of October, he found that they yielded syrup and saltpetre, but not a particle of sugar.

It is evident that the plant ought not to remain in the ground long enough for a second set of leaves to commence. If the first have generally drooped and withered, and the weather is still so warm as to keep up vegetation, the beets ought to be taken up without delay, though it be in July. The secondary foliage is formed at the expense of the sugar. If the beets are for forage this is bad ; if they are for sugar, it is fatal. We however look upon this precocity of the American beet as an advantage to the country, as it will enable the manufacturer to begin his operations a month earlier than they do in France, and of course to have seven months for working up the green beet in lieu of six, the most that they reckon upon there. Another advantage will be that the American manufacturer will not be obliged to lay up so large a proportion of his material in pits. This will save him considerable expense, and augment the amount of his product. To those who proceed upon the plan of dessication, the advantage, though not to be despised, will be somewhat less.

We have observed under another head that the beet sugar manufacturer, should sow different fields, or different parts of the same field at intervals of a week, from the latter part of April to the first part of June, during a period of five or six weeks. If he has done so, his crop will come forward *in echelon*, both for weeding and digging; two, three, five or ten acres, according to the size of his works, will be ready for digging by the 1st or 5th of August, an equal quantity by the 10th or 15th, and so on until the season of vegetation is closed. All the stock, except that for the daily supply of the works, should be left in the ground as late as possible; and not more than three or four days' provision should be on hand at the factory, until the approach of the season for frost. If at that time there is any portion of the crop which is not ripe, that ought to be worked up first. The same remark applies to those beets which, though ripe, are very large, hollow and aqueous. These ought to be separated and worked among the first.

Beets will bear more or less cold according as they are more or less rich. Ordinarily they will bear before they are digged 22°, or 10° below freezing point. After digging they will bear 28°, or 4° below freezing. If, unfortunately, any beets should be frozen in the ground, it will be best to let them alone for eight or ten days. The plant has a recuperative power, by which its organization, deranged by the shock, is gradually re-established. At Northampton in 1838, there was a severe frost about the last of October. On the beets taken up the next day, there was a loss of 20 per cent. On those which were permitted to stand ten days longer there was no loss at all. They appeared perfectly sound.

Undoubtedly the digging ought to be done before the days arrive in which severe frost is expected. From the 15th to the 25th October is late enough in Massachusetts. Dry days are preferable for the operation, but it would be imprudent to wait beyond the 20th October for them. Notwithstanding their long experience in France, and the comparative mildness and uniformity of their temperature, heavy losses by frost are not infrequent.

If the land be light, and the beets grow out of the ground, they may be readily pulled, and no implement will be necessary to dislodge them. When this cannot be done, a spade, fork or plough is employed.

The fork has two stout tines, 1 foot long, and 3 or 4 inches apart.

The root digging plough has no mold board, but a triangular bit of wood, resembling the point of the chip. It enters deep, and lifts and loosens the earth under and around the roots without displacing it.* The roots being loosened by either of these means, a boy seizes them by the tops, shakes, and lays them two and two, heads one way, tails the other, and necks even. A workman with a keen spade passes, and by a well directed blow, decapitates them precisely at the foot of the lower leaf-stalks. This is executed with such address and despatch that he continues all the time upon a moderate walk. One person can cut as fast as several can lay. After this it used to be the practice to let them lie two or three days in the sun, but this is now recognised as an error. They are not to be exposed to the sun any more than can possibly be avoided. Heat and light dispose them to enter into decay much sooner than if they are kept in coolness and obscurity. As soon as they are topped, they should be gathered into small heaps, and well covered with the leaves. In this situation they will dry.

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§ 11.

KEEPING.

On removal from the heaps, the beets will go to the factory, if they are wanted there, and if not to the pits. If they are to be dried, they will be submitted to that process before severe cold comes. They ought to be placed in sheds to protect them from the sun, and covered with straw to protect them from frost. Beets which are to be worked green must be pitted, and even if they are to be used only

* In the agricultural machine shop of *Mr. Dombasle*, at *Roville*, six leagues from *Nanci*, such ploughs of his invention are constructed. At the manufactory of *Thurn & Taxis*, at *Dobrawitz*, near *Yungbunzlau* in *Bohemia*, a very admirable instrument of this sort is sold for three or four dollars. It not only serves for digging roots, but also for hoeing, hilling, lifting the subsoil and cleaning ditches.

for feeeding, it is profitable to pit a part of them. If it be well done, they will come out fresher and finer than from any other situation. We leave cellars and store-houses out of the question. They would be very expensive for a large manufactory, and not so good as pits. When small manufacturers shall arise, good, capacious, dry and well aired cellars may be of service to them.

The cheapest and best way of keeping a large quantity of beets or other roots is in pits. These should be sunk more or less deep, according as the spot chosen for the purpose is more or less dry. We have never seen them less than one nor more than three feet deep. In high and sandy ground they might well enough be made somewhat deeper. The width now generally adopted is only 2½ to 3 feet, and the length sufficient to contain three tons. The large heaps which used to be formed, were found to be too liable to heat and take hurt. Those were 4 to 6 feet wide, and of indefinite length; or they were conical, and 4 to 6 feet in diameter at the base. Great attention is now paid to ventilation, an indispensable requisite to the preservation of roots. Various means are employed for obtaining at pleasure a renewal of air. We shall describe each, and leave the American manufacturer and farmer to select for himself. The simplest is to sink in the bottom of the pit a gutter or culvert through its whole length, of the depth and width of a spade. By continuing it up the ends of the pit, it will have orifices at the open air. Across this gutter beets are laid with regularity, after which the pit is filled to the surface promiscuously; but there are those, who prefer to lay the whole with regularity. In either case they should be stowed with such gentleness as not to bruise or wound them. An ingenious and experienced manufacturer at Arras assured us, that a bruise or wound was as bad for a beet as for a winter apple. Hence the old practice of striking them together or against anything to rid them of dirt, is discarded. In fact, it is now thought that beets keep best with their dirt on them. A manufacturer near Arras, both a scientific and practical man, declares that "the best preserved beets have been those which were committed to the pits all covered with mud." Above the surface of the ground, the heaps are continued by laying up the roots with regularity, so as to taper off at 4 or 5 feet from said surface. The form resembles that of the old fashioned gable roof, without its angles. It is called in France *the ass's back*. The heap is now to be covered with earth in the manner that coal-pits are covered; but it is not to be completed at once. The covering being carried up two thirds of the height, the work is to be abandoned for a week or two, while the roots dry, and the first heat of the heap passes off, care being taken to keep the exposed beets covered with tops or straw. After such an interval the covering may be completed. On arriving at the summit, wooden air flues, or old joints of stove pipe, 5 or 6 inches in diameter, or bundles of faggots of that size, are to be placed endwise on the ridge of the heap, every three feet of its length. This being done, the dirt is heaped on between and around them to the usual depth, which in France is 18 inches. Here, in the Northern States, it ought to be 2 feet. The whole of this covering must be compactly laid and beat down with a shovel or spade, so as to turn off the rain. When freezing weather comes on, the culvert and air-flues are to be well stopped with straw. On mild days they should be opened. By introducing a thermometer into one of the air flues, (unless fascines have been used) the manufacturer may at any time perceive the temperature of his heaps. The most favorable point for their perfect preservation is 52° of Farhenheit.

The pits should not be in the same place in successive years. And in cellars for keeping sugar-beets, the sand on the bottom should be changed every year. The best place for the pits is in the field where the beets grew. This earth is said to be more congenial to them, and to preserve them better. In any other place it makes large mounds of earth, and if there be a change every year, it would require a vast surface. Care however should be taken to make the pits in a situation where they can be conveniently reached in winter by carts and sleds. The freezing of the beets in the transition to the factory is not the slightest injury, provided they are worked up before they thaw. On the contrary, some think, and not without good reason, that they yield their sugar more easily in consequence.

If the ground be low and moist, it is advisable not to dig at all for the heaps, but to form the gutter, and lay up the heaps on the surface. Where there is the least danger of an accumulation of wet about the bottoms of the heaps, it is necessary to make trenches deeper than the heaps, running parallel to them. This may be done without additional labor in the mere act of covering the heaps. If these are situated in ranges, one trench serves for two. The pits should present their ends to the north, or to the cold blasts, whencesoever they come; and should be, as far as practicable, in a sheltered situation.

Another mode is to form circular pits, and to lay up the beets in the shape of a cone, putting a pole in the centre, as in a stack of hay. After the heap is completed and covered, the pole is withdrawn, and the hole it leaves serves as an air flue. This fashion has nearly gone out. Instead of the culvert, bundles of faggots are sometimes disposed along the bottom of the pit, and others placed transversely above the surface passing through the heap, and its covering. In this case holes are to be left at each end of the heap, to be closed in cold weather, as also at the ends of the fascines, placed transversely.

In Bohemia, in the year 1836, an improvement in keeping beets was supposed to be made. This consisted in placing a large tube made of boards on the surface of the ground, the length of the proposed heap. This tube is pierced with holes and traversed every two or three feet by shorter ones, extending far enough to have their orifices outside of the covering. At the place of intersection of each of the horizontal tubes, perpendicular ones of smaller diameter, (5 or 6 inches,) are raised, which reach out at the summit, like the air flues before described. These present the opportunity of introducing a thermometer. Of course the orifices are to be all stopped in freezing weather. With this apparatus for ventilation, they make their heaps five feet wide, four feet high, and of indefinite length; but it must be desirable in all cases to make heaps no larger than the factory can work up in one day.

§ 12.

RAISING SEED.

Every cultivator of the sugar-beet, ought to raise his own seed, otherwise he will be liable to get that which is old and bad.

The seed beets must be selected at the time of digging. The middling-sized roots, say two to three pounds in weight, being solid, regular, cone-shaped, and small-necked, are to be selected. The tops must be cut above the chit. Beets with white leaf-stalks only are to be chosen, the red-vein-leaved being considered degenerate. The seed beets are to be dried in small heaps as before described, and then removed to a dry and well aired cellar and buried in sand, all except the head, which is to be left free. Their position should be slightly oblique. They may be still better preserved in pits two feet deep, covered at the top with cat-sticks laid close, and earth thrown upon these.

As soon as the fear of frost will permit, these beets are to be set, or transplanted. The soil must be rich, deep and mellow, and the roots entered with a spade two to two and a half feet apart. Some are of opinion that light land moderately manured, is preferable, as producing better seed. The situation should be sheltered from boisterous winds, and the aspect sunny. When the stalks are fifteen inches high they must be protected with stakes, and straws or strings. Several stakes may become needful according to the size of the plant. It must not be blown about and prostrated. The ground is to be kept clean and loose.

About September the seed is to be gathered. For this purpose the main stalk, or only the branches may be cut with a sickle or bill-hook, bound with straw in small bundles, and suspended in a garret, which is well aired. When they are perfectly dry, they are thrashed, like wheat or oats, and cleaned with a winnowing machine. Then a sieve, which will permit all the seeds to pass and retain nothing but bits of straw and dirt, is to be used; and after that another sieve, which will pass all the little and imperfect seed, and retain only those of a large and uniform size. This is the seed to be preserved. Let it be spread on sheets in a dry, airy place, and after a while put up in casks and placed in a dry situation. Bags will do if they are kept out of the way of mice.

Each seed-beet will yield about seven ounces of seed. If they are set two feet apart, there will be 10.890 plants to an acre; if at two and a half feet, there will be 6,969.

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§ 13.

PRODUCE AND EXPENSE OF THE CULTURE.

In the Department of the North, in France, the average produce of an acre is 15 tons, 600 lbs. This is the highest in that country. In the two adjoining Departments (Aisne and Pas de Calais,) it is 12 and 14. As we recede from old Flanders, the head-quarters of the beet sugar industry and of French husbandry, the rate declines to 10 tons per acre. The general average is 13 tons. In Germany the general average is 15 tons.

At Northampton the results have not varied essentially from the above. The best fields have yielded 15 tons, but they were not trimmed as closely as they usually are in France; if they had been, *i. e.* if the neck with all its leaves, dry and green, had been removed, the gross weight would have been reduced 10 to 20 per cent, and the merchantable produce would have been 13 tons to the acre. Beets with thick and unshaped necks, are more common in our fields than in the French. This is owing to want of depth and mellowness in the soil. Sugar-beets of a perfect form, *i. e.* cone-shaped, with small, well defined necks, are seldom found unless they grew entirely in the ground. When the root rises above the surface, the neck becomes unnaturally enlarged, and the superior part of the root, scragged, with secondary necks and dwarf leaves; so that it is sometimes hard to say where the root ends and the neck begins.

Our beets, with slight exceptions, have not attained a degree of saccharine richness equal to that of the French. Instead of 10 to 10½ per cent. of sugar, they have contained but 7½ to 9 per cent. We attribute this inferiority to the inexperience of cultivators, and mainly to improper manuring. The probability is that, with equal culture, our beets will surpass in saccharine richness those of France.

Enormous crops are frequently obtained in that country. Thirty tons an acre are not uncommon, and 45 have been produced. In England they considerably exceed this. We have been informed by *Mr. Kyan*, the inventor of the anti-dryrot process, and interested in an establishment for the manufacture of paper, brandy, and vinegar from beets, that there the *average* crop is 30 tons per acre, and the maximum 50, being, at 58 lbs. to the bushel, no less than 1931 bushels; and capable, if as rich as the beets of France, of making 8960 lbs. of brown sugar. But it is by no means to be supposed that they are thus rich; still it is not impossible. One root to every square foot, and of the weight of 2½ lbs., would be 54½ tons to the acre. It would be strange if a plant easily attaining the weight of 7 lbs., and usually ranging between ¾ lb. and 5 lbs., could not by care and skill be brought, on an average, to 2½ lbs. But the English ton is 20 cwt. of 112 lbs. In that case 50 English tons would be 5½ tons nearly, more than the like number in Massachusetts.*

* Why an alteration of the *cwt.* should have been made in our State, before a general revision of the system of weights and measures, known to be in the contemplation of Congress, to whom that duty is assigned by the Constitution, was made, is not apparent.

Every one knows that it is not so important what the standard and denominations of weights and measures are, as that they be uniform and established; and this was the reason of delegating the power over this subject to the general government.

Whatever may have been the design of this local interruption of the harmony of the existing system, the effect of it, and the only important effect, is to facilitate extortion. We are informed by various classes of consumers that no reduction of *price* has taken place in conformity with the reduction of quantity. We presume that many persons purchase without being aware of the change, and pay for 2000 lbs. of *hay*, *coal*, *&c.* what they suppose they are paying for 2240 lbs.; and for 100 lbs. of sugar or other merchandize, what they intend and would only consent to pay for 112 lbs. A like injustice in all charges for freight and transportation is created by this law.

Those dealers, who had produce or merchandize on hand at the time of its passage, and those who purchase at English weight, which we believe is also the weight of all the States except *New York*, have sold and are selling at a profit of 12 per cent. on *weight* in addition to their legitimate profit on the cost.

Whenever the *ton* is mentioned in this treatise, the present, (may it soon be past,) ton of Massachusetts is meant.

Some extravagant stories have been told in the public journals of the yield of sugar-beets in this country. For instance, a gentleman of Pennsylvania is represented to have raised 62½ tons on one acre. There have however been acres of mangel-wurtzel in Massachusetts, which have carried premiums for 33 to 43 tons.

The cost of raising sugar-beets in France varies from 10 to 20 *francs*, the 1000 *Kilogrammes;* which is $1,72 to $3,44 per ton. The prevailing price in that country is $2,75 per ton. In the United States the little experience we have had in raising root crops, would make the expense of cultivating exceed that price. It may be presumed that this expense will be reduced, when we shall have become thoroughly acquainted with the management of the crop, and especially when we shall have become familiar with the most improved implements for its cultivation. At present we know no account of the actual cost of cultivating beets in the United States. We have seen a number of estimates, based on more or less practice, and the great agreement which we find among them, satisfies us that the general result may be relied on. They are all very near $40 an acre. The lowest is $35 and the highest $44. The following is from a farmer of Northampton, who has had the advantage of several years' experience in raising the sugar-beet.*

Rent and manure	$18 00
Ploughing and harrowing . . .	2 00
Carting manure	1 00
Seed and planting	2 00
First hoeing	3 00
Second do. and thinning . . .	5 00
Third do.	3 00
Digging and carting, or pitting . .	8 00
Total	$42 00

It is probable that some of these items will apply nowhere except to the low lands on Connecticut River. Estimates

* Mr. Hiram Ferry.

or accounts made in different localities, or by different persons in the same locality, will never precisely agree. This has been the case in France, where unusual pains have been taken to perfect the statistics of beet sugar.

The above estimate brings the cost of raising beets at 13 tons an acre, to $3,23 a ton ; and at 15 tons an acre, to $2,80. Suppose them to be sold at $4 a ton, ($5 is too great to be long sustained,) the proceeds would be at 13 tons an acre, $52, and the net gain $11 an acre. At 15 tons an acre the proceeds would be $60, and the net profit $19. We suppose that a crop, which will fully pay the rent of land at 6 per cent on its value, the price of manure, and the wages of labor, is considered an advantageous one. We believe it to be rare for a crop in New England to do more than this. Take, for example, our principal one, Indian corn ; the account will stand thus,—

Rent and manure . . .	$15 00
Ploughing twice	3 00
Carting manure	2 00
Planting	1 00
Hoeing	3 50
Cutting and stacking . . .	3 00
Carting and husking	4 00
Total	$31 50

The average produce is about 25 bushels an acre. The stalks and husks are estimated at $5. We suppose the stalks to be left on the corn, not cut or topped, a pernicious custom, by which most of our farmers destroy 20 bushels out of every 100 of their Indian corn.* Thus a fair crop of this corn gives a return of $30, scarcely covering the cost, and this without allowing anything for shelling We are well aware that many farmers get more than 25 bushels an acre. The Connecticut River meadows give 30 bushels, but this very fact proves that the general average must be a good deal less. In the case of wheat, rye, barley and

* See the details of experiments on this subject by *Hon. Wm. Clark, Jr.*, of Northampton.

oats, the account would be still more unfavorable. Either of them, or Indian corn itself, is a more uncertain crop than sugar-beets.

Thus far we have not seen in this country nor heard of, an enemy to the beet except the *cutworm*, nor of this except in one instance. This insect may be destroyed by ploughing in the fall and exposing the eggs to the frosts of winter, or, if this has been neglected, by pouring around the plants a decoction of elder or walnut leaves. Lime compost would probably be of service for the same purpose.

Broom corn is the most profitable crop, carried by the Connecticut River meadows. The expense of production will not vary a dollar from that of the sugar-beet. The average quantity of *brush* to an acre is 600 lbs., worth at the price of the last season $48. The seed seldom ripens. When it does, it is worth $15; when it does not, it is worth nothing; $5 is considered a fair average, which added to $48, makes $53, giving a net profit in this business of $11 per acre. But neither of these crops is an *enriching* or a *cleaning* crop: the beet is both, exterminating every noxious plant, and leaving green stuff on the ground, which ploughed in is equal to a quarter or half manuring, *i. e.* to 5 or 10 loads of manure per acre, and the expense of carting it. The addition which the beets, worked up in a sugary, makes to the stock of manure, is a subject which belongs to the SECOND PART of this treatise.

NOTE. Mr. Harrison O. Apthorp, of Northampton, one of the early cultivators of the sugar-beet in this country, has informed us of the remarkable growth of herdsgrass as a successor of sugar-beets on his grounds. The crop was pronounced by the oldest farmers in Northampton village, superior to any of the kind they had ever seen in the Meadows.

one, the amount would be [illegible] ... [illegible]. [illegible] of them, it would [illegible] more [illegible] than they [illegible] been.

Thus far we have not seen in the country, nor heard of, an insect in the [illegible] ... [illegible]. This [illegible] may be obviated by [illegible] in the fall and exposing the [illegible] to the action of [illegible], if this has been [illegible], by [illegible] the [illegible] ... [illegible]. Lime [illegible] would probably [illegible] for the same purpose.

[illegible] is the usual product [illegible] by the Orient [illegible] ... [illegible]. The [illegible] of [illegible] does not vary ... differ from that of the sugar beet. The [illegible] ... 600 lbs., worth at the price of the last season [illegible]. The [illegible] When it does, it is worth [illegible]; when it does not, it is worth [illegible] ... which added to [illegible], makes [illegible], giving a net profit in this [illegible] of [illegible] per acre. But [illegible] ... the loss of both [illegible] and [illegible] ... on the ground, which [illegible] is equal to [illegible] ... per acre, and the expense of [illegible]. The [illegible] which [illegible] ... in a factory, makes [illegible] of [illegible]; it is a subject which [illegible] ... of this [illegible].

[illegible] ... one of the early cultivators of this [illegible] in this country, [illegible] ... of the [illegible] ... on the [illegible] ... and [illegible] in the [illegible].

[illegible]

PART II.

THE MANUFACTURE OF BEET SUGAR.

THERE is such a variety of methods and machinery for making beet sugar, and the art is still in such a state of progression, that it is hard to decide which of the several systems to choose, or whether it be not best to reject them all, and await further developments. In this state of the case we propose to describe every method and modification, which is anywhere deemed important, adopting as the foundation of our work, the common French system of *grating and pressing*. Here at all events there is something solid. Here at least is a boon to agriculture, which we are persuaded has no parallel in the history of that art, since the invention of the plough.

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§ 1.

CLEANING.

In the former part of this treatise, we have cautioned the diggers not to smite the beets together, nor against any hard substance. The consequence must be, especially if they grow in a moist or clayey soil, or were taken up in wet weather, that they will be more or less encumbered with dirt and mud. This is now considered a help to their preservation, though it may be difficult to say how far the effect is owing to the presence of dirt, or to the absence of bruises. We know that the latter are sufficient to make the beet enter prematurely into decay, but experienced and careful manufacturers are convinced that an envelope of its native earth has a considerable agency in preserving the beet in a sound state. We are inclined to this opinion, because it is agreed on all hands that the beet is best preserved, so long as the temperature of the weather will admit, in the ground where it grew. It seems to follow that a portion of the same earth carried with it, and partially covering it, will contribute in a degree to the same end.

That the dirt be removed when the roots are to be submitted to the grater, is not material, as respects the quantity or quality of the sugar, but it is of much importance to the safety and efficiency of the grater. Pebbles and sand break and wear the instrument. Moreover, the pulp is injured as feed by a great deal of dirt. The presence of it is also disagreeable to the workmen in every stage until it is arrested by the sacks at the press. Finally, this same dirt being the richest of the field, and very minutely divided by the process of removal, becomes valuable for the manure heap.

The beet is often cleaned by simply scraping and separating the small and fibrous roots with a knife. We have known a number of manufacturers who contented themselves with this operation; but a great majority submit their beets either before or after trimming to a plentiful wash. This is executed in two ways.

1. In a large tank or cistern, composed of planks and a frame six to eight feet long, three feet wide and four feet deep. Within a foot or a foot and a half of the top is a false bottom formed like a fire grate, of bars or slats, or of thick boards pierced with holes. The water flows into the tank until it rises half a foot above the false bottom, which, it will be perceived, is so high as to give ample room for dirt to accumulate beneath. The beets are cast

into the tank and rest upon the false bottom, raising the water higher, and themselves rising to its surface. A workman, standing upon a banquette, or a platform by the side of the cistern, stirs and scrubs them with a birch broom. When they are clean, he takes a shovel, resembling a common cider-shovel, pierced at the bottom of its concavity with a number of large holes, and throws them from the tank into a heap ready to be borne away to the grater. This mode of washing is most complete, and one man, if the beets be served to his hand, can perform it fast enough to supply a pretty large establishment. The reader will readily conceive that such a shovel as we have described, will take up the beets and leave the water. The bringing of the beets to the tank is occupation for a second man. He should place them in baskets by the side of the washer, not empty them into the tank, otherwise this will often be too full, and fresh dirt be added, when a charge is cleaned and about to be removed. The washer should take the entire care of pouring in and shoveling out the beets. The cistern must be placed at a slight inclination lengthwise, and have a man-hole in the lower end, which must be opened every day, and the mud hauled out with a scraper. It flows off in a thick current to a field or dunghill.

2. The other and most usual way of washing is with a machine moved by steam, or any first mover. To form an idea of the washing machine, let it be supposed that a hollow cylinder is mounted upon the tank, and revolves in such a manner that nearly half its diameter is plunged in the water. In this case the tank has no false bottom. The cylinder is formed by bolting to three or four wooden rims, fixed upon spiders, long and thick staves two to three inches wide and one and a fourth inches apart; of course as the cylinder turns, the water passes through the interstices of the staves. One end of the cylinder is placed four inches higher than the other. A hopper terminates against the upper end, which is wholly open, except that it is crossed by four arms of the spider supporting the rim at that end.

Into this hopper the beets are cast, and slide from it into the cylinder, which constantly revolves. The beets, by the inclination of the cylinder, tend towards its lower end, and undergo the action of the water, while traversing its entire length. To increase the efficacy of this action, *fumblers,* resembling enlarged teeth of geering, are firmly attached to the interior sides of some of the staves. Sometimes also iron pins, six inches long and three quarters of an inch in diameter, are placed in a spiral row, eight inches apart, for the same purpose. This appendage is called *the snail,* and occupies four or five feet of the central length of the cylinder.

By these means the beets are rubbed and shaken in the water, in a manner analogous to the application of the hand to the same purpose.

The beets discharge themselves at the lower end of the cylinder by an opening, which is only one sixth of the area of that end, the remainder being closed by a disk or head. Upon this open sextant there terminates interiorly an Archimedes' screw, which takes up the beets in the cylinder and casts them from it into a hopper, a basket or a heap. If the grater be placed on the pavement, level with the washing machine, the beets are deposited by the latter near it. But if the grater be placed aloft, the reasons in favor of which arrangement will be explained, the beets are raised by an elevator or windlass up to the apartment or platform of the grater. If the beets are neatly and closely decapitated in the field, and arrive at the washing machine free from decay, they may pass through the process now described without any scraping or trimming in the factory, which will be a great economy of labor. If any of them arrive at the grater, unfit by reason either of dirt or decay, to be submitted to it, they may be thrown aside by the boys who serve the grater, to undergo the needful dressing.

The most perfect washing machine which we have examined, was that of *Mr. Roseau,* at Feuchy, near Arras. It consisted of two cylinders, mounted on their separate tanks, one placed high, so that the beets when discharged from it, were conducted by an inclined plane into the other, from which they issued perfectly clean. This contrivance, according to the statement of the superintendent, saved the labor of fifteen hands in scraping and trimming. In a great establishment it is necessary to haul the mud from the tank once in six hours.

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§ 2.

GRATING.

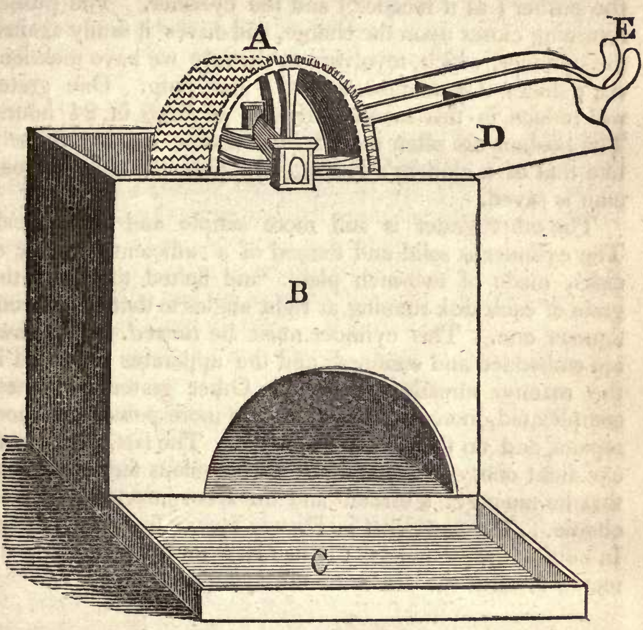
The grater, called in France a *rasp*, is a cylinder either solid or hollow, and set as to its exterior surface with many saws. This cylinder bears on a solid frame, either of wood or iron, and revolves at least 400 times a minute. Some manufacturers it is said, have given it a velocity of 1300 times a minute. It turns in part within a case or box, made perfectly close, except a small section, where a hopper terminates upon the periphery of the cylinder, and a hole in one side near the floor, where the grated material, now called *pulp*, is withdrawn. This is effected with a wooden shovel, similar to that already described except that it is without holes. The superior part of the cylinder is completely covered by a movable sheet iron or wooden cap. At one side of the cylinder is a small hopper, divided into two compartments by a longitudinal partition. In each compartment and exactly filling its breadth, is an oblong block, rolled at its exterior end, so as to be seized and propelled by the hand. The interior ends are concave, so as to correspond with the surface of the cylinder. These instruments are called *pushers*. They act much in the manner of clothiers' fullers, but in their descent towards the cylinder they are arrested by shoulders, so that they can never come quite in contact with the cylinder.

The essential part of the grater is the cylinder, of which there is a variety of constructions, but the form and dimensions are everywhere nearly the same. We shall content ourselves with describing two, which operate perfectly well, and which the proprietors themselves mainly constructed.

The first has two cast iron heads, fixed to an arbor or axle, 1 foot apart inclusive of the rims. To the rims are confined by bolts, stout oak staves, 4 inches thick, 2½ inches wide and 1 foot long; thus the staves complete a barrel or drum. In these staves the saws are embedded lengthwise by cutting small channels with a handsaw. The saws are of equal length with the staves, 1 inch in width, and toothed on both edges. The teeth are in the form of equilateral triangles, and the distance between the points is $\frac{1}{6}$ to $\frac{1}{8}$ of an inch. The fineness with which the grater divides the material depends entirely upon the teeth, and the quantity of juice expressed by a given power depends upon the fineness of the grating. Mr. Dombasle suggests that it might be advantageous to make the extremities of the teeth *square*, as Achord, the first manufacturer of beet sugar, in fact, did. This would *scrape* rather than tear the beet. It would probably protract too much the operation. Of late, they have reduced the dimensions of the teeth, and to compensate for the comparative slowness with which these execute the work, they have sought to give the cylinder that enormous velocity which we have mentioned. The diameter of the cylinder is usually 18 inches, but sometimes it is 22. The number of saws varies from 120 to 160, some disposing them at ¾ of an inch apart, others at ⅝, and others at ½ an inch. The saws being sunk till the bases of the teeth coincide with the surface of the cylinder, the whole is plunged in water until, by the dilatation of the wood, the saws are firmly fixed in their homes. Each extremity of the arbor carries a wooden pully. After the grater has been used about one month the cylinder is turned end for end, and thus the opposite side of the teeth presented to the material. It will then serve for an equal time; after which the saws are inverted, and the fresh teeth of the other edge employed in the same routine. To make this change, as also to provide against accidents from pebbles concealed in the forks of the beets, a second cylinder is to be kept always in readiness to take the place of the first, while this is shrunk, and the saws taken out, filed or repaired, or new ones substituted.

GRATER.

Fig. 4.



1 *foot to ½ inch.*

A. Cylinder.
B. Case.
C. Table, or trough.
D. Hopper.
E. Pushers.

The action of the grater is as follows. The cylinder is put in motion by a band or by geering, though the latter is not so much approved. A man seated at the upper end of the hopper, which is but slightly inclined, puts the pushers in alternate motion. Two boys, having a supply of beets at hand, place one or more, according to their size, betwixt the pusher (as it recedes,) and the cylinder. The pusher returning closes upon the charge, and drives it firmly against the cylinder, which, revolving at the rate we have mentioned, reduces it instantaneously to a fine pulp. One grater will reduce in this manner 30 tons of beets in 24 hours. The pushers are often moved by a double crank, precisely like that of a clothier's fullers, and thus the labor of one man is saved.

The other grater is still more simple and economical. The cylinder is solid and formed of a sufficient number of disks, made of two-inch plank and bolted together, the grain of each disk running at right angles to that of the contiguous one. This cylinder must be *turned*. The saws are embedded and confined, and the apparatus managed in the manner already described. Other graters are more complicated, more expensive, require more power, and more repairs, and do their work no better. The last, which is an excellent one, can be made by an ingenious farmer, except that he must get it turned and the arbor inserted by a mechanic. The saws cost in France four or five cents apiece. In cutting the channels, the handsaw must be carefully directed towards the *centre* of the cylinder.

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§ 3.

PRESSING.

At the foot of the grater, and at the side, where the pulp is taken out, is planted on the floor or pavement, a wooden table or trough, (Fig. 4, C.) lined with copper or zinc. This is capable of retaining the liquid which falls upon it. On this table a workman takes his station with the shovel, and another presents the open bags in rapid succession over the table. The first deposits a shovel full in each bag; the second passes each bag as soon as it is filled, to a pivot-table, lays it upon an osier hurdle, and folds down the mouth so as to secure the contents. A third workman, armed with an instrument like a rolling pin, except that it is flat instead of round, spreads and levels the contents of the bag, and places a hurdle atop. Upon this he receives, and treats in like manner a second bag, and so on until a pile of 10 or 12 bags is formed. The table is then turned until the part supporting the pile is near the press, to the follower of which it is immediately transferred. Meantime another pile is formed on the vacant end of the table. This is in like manner transferred to the press; and when 30 to 40 sacks are accumulated upon the press, the power is applied and the juice runs in torrents.

The press universally employed is the hydrostatic. It is the most costly and the most economical. It operates with unrivalled force and celerity. We shall not describe an instrument so generally known and so easily procured in this country. It is usually worked by the general moving force of the factory, but the levers are liable to be broken, and it is prudent to have handles which can be substituted, and a man assigned to the service of the pump until the lever can be repaired.

In a quarter of an hour the pression is complete. The charge is withdrawn by the workman stationed at the press. The hurdles and sacks are taken off one by one; the former are placed by the side of the workman at the table, and the latter are tossed to one or two workmen whose occupation is to shake out the dry pulp. The bags being emptied are returned to the hand of the workman, who holds them to receive the pulp at the grater.

Some manufacturers prefer towels to bags for pressing pulp. They find them easier to empty and to clean, and when they are sufficiently worn they can convert them into bags for storing and marketing their sugar. These towels are 5 feet long and 3 feet wide. In charging them it is necessary to spread them upon an iron hoop in the form of a paralellogram, which measures the quantity proper for each towel. This being leveled the flaps are folded down, and the towel is then treated as a sack.

The name of pulp is given indiscriminately to the grated material and the residuum after the pression, but the last is properly called the *dry pulp*. It is just dry enough for feeding cattle and sheep without the necessity of their going out of the stalls to drink. In Europe neat cattle are tied by ropes 4 or 5 feet long, attached to their horns and made fast to staples. This arrangement gives them ample room to stretch and repose themselves in the most comfortable manner. They are furnished with plenty of clean straw for their beds.* The value of the dry pulp in France as a marketable commodity, is small, not exceeding $2 a ton, but fed out on the spot it is worth $5. The reason of so great a difference is that this feed must be used fresh, and those who have one or a few animals to feed, find it troublesome and expensive to go often to a distant factory for it. The dry pulp usually contains more saccharine matter in proportion to its weight than the original material.

An ox comsumes 60 to 75 lbs. of dry pulp per day ; a sheep 4 to 5 lbs. A factory working up 25,000 lbs. of beets per day, will feed 70 oxen, or 1000 sheep ; or 50 oxen and 300 sheep ; or 30 oxen and 600 sheep. Wheat straw is usually given with the pulp, and toward the close of the fattening, oil-cake or meal is added. Three months suffice for fattening a bullock, and two for a sheep.

It follows from the foregoing that a vast quantity of manure is made on a beet-sugar farm. It is usually estimated at four times the ordinary quantity. Its quality, it being that of sheep, hogs, and horned cattle, is of course excellent.

* *Linter* or *leanter* is a provincialism, but so descriptive that it deserves to become general. It is evidently derived from *litter*, an original and leading idea of a stall for cattle, which usually lie down. When our farmers shall have recurred to this primitive notion of a cowhouse, their farms, as well as their beasts will feel the change. Nearly all the liquid manure of our stables is now lost. In the French provinces they use *litiere* in the same sense as our plain people use linter or leanter. The root of these words is *lit*, a bed.

§ 4.

DEFECATION, OR FIRST CLARIFICATION.

The table on which the piles are composed tor the press has a rim 2 inches in height, and a hole through the centre and through the pivot. By this the juice, escaping during the formation of the piles, passes, and is conveyed by a conduit to the great gutter, or main pipe, forming the communication between the presses and the *defecating pans.* The number and construction of these pans vary. Each manufacturer, or a machinist and engineer for him, must determine these according to the quantity of material to be worked up, the capital to be invested in the works, and the system of heating to be employed. In general the capacity of the defecating pan or pans ought to be 1 gallon for every 50 lbs. of beets, worked up daily, if the heating be by furnace; and 1 gallon to every 75 lbs. if the heating be by steam.

The defecating pans should be deep. Originally their depth was made equal to their diameter; but the ratio of the depth to the diameter, generally preferred, is $\frac{5}{8}$. Thus if the diameter be 4 feet we have this proportion,—

$$8 : 5 :: 4 : 2\tfrac{1}{2}.$$

The capacity usually given to the defecating pans is 214 gallons, and the number of them 3. It is desirable, if the material operated upon daily will justify it, to have 2 defecating pans at least, but it is not expedient to reduce them for this purpose to less than 30 gallons. Such a pan will admit 25 gallons of juice; the remainder, $\frac{1}{6}$ of its capacity, is necessary for the rising of scum, and to prevent overflowing by ebullition.

The most approved defecating pan is composed of a double hemispherical bottom of cast iron, and a copper ring or zone attached to it, and forming $\frac{2}{3}$ of the capacity of the vessel. At the inferior point of the hemisphere is a large discharging cock, penetrating both bottoms, and so adjusted as to be capable of entirely emptying the pan. A pipe inserted in the exterior bottom admits the steam into the chamber of the double bottom, and others carry off the waste steam and water of condensation. These pans are heated at a high pressure, and accidents have resulted from neglect to open the waste cock.

Thus far we have spoken of defecating pans calculated for steam only. But it is probable that many beet-sugar manufacturers, perhaps a majority in this country, will commence with furnaces on account of the great outlay, which a steam aparatus requires. A cheap and excellent defecating pan for a furnace, is made of rolled copper $\frac{1}{12}$ of an inch in thickness, its form the frustum of a cone, the bottom being perfectly flat. It is set in brick, and its capacity, if desirable, may be a little increased by raising the upper surface of the brickwork, called the bench or glacis, one or two bricks above the edge of the pan. The whole bottom, except a narrow border resting on the brickwork, is exposed to the direct action of the fire; and the heat is further economised by leading two flues from the anterior part of the furnace, entirely round the sides of the pan, and uniting them in a chimney or common flue in the rear. This is a cheap and durable pan. After ten or fifteen years of service the material is still worth half its original cost. The defecating pans are always placed at an elevation of 8 or 10 feet above the floor or pavement. If the heating be by steam they may be advantageously placed in the second or third story.

The manner of conducting the defecation is as follows. The juice coming from the press or presses, is thrown into a defecating pan with as little delay as possible. For this purpose it is very desirable that the grater and presses be placed at such an elevation, that the juice will run from them into the pans. It often happens that this disposition is not convenient, and then the juice is conducted into a cool reservoir under the floor or pavement. From this it is pumped into the defecating pans. The juice sustains some injury from the friction and delay, unavoidable in this transition.

The fire is to be lighted or the steam admitted, when the pan is one third full. By this means the juice is sooner brought to a degree of heat at which alteration by atmospheric influence is no longer to be apprehended, and also the defecation is expedited. When the juice has reached the temperature of 170° to 190°, or such that the finger can bear it for a second, lime is added in the following manner.

A quantity of the purest unslacked lime that can be obtained, is taken in the proportion of $\frac{2}{3}$ oz., or about three hundred grains to every gallon of juice. If it exceed this, it will not be amiss, as it is always best to *prepare* enough. This is placed in an iron vessel, and hot water, equal in weight to one quarter of the lime, is sprinkled upon it at several times. This will slack it, and if it be freshly burned and preserved in a caustic state, the division effected by the process will be very minute. It is useful to cover it during the operation in order to retain the heat and vapor. In ten or fifteen minutes the whole is thrown into a pail, and water (in some manufactories juice,) is added until a milk or pap, measuring 13° or 14° by the hydrometer of Beaumé, is formed. In measuring the density, the operator is liable to be misled, unless he shake the mixture well in his proof-tube, the instant before plunging the hydrometer.

It is useful to pass the solution through a cullender for the purpose of separating any lumps or biscuits, which it may contain. The common American lime is seldom proper for the sugar factory. It contains a good deal of potash resulting from the use of wood in the lime kilns. For the manufacture of sugar lime ought to be burned with pit coal and preserved in sealed jars. If none but common building lime can be had, it ought to stand a day in the state of milk, and the water be decanted three or four times. In this case it is well to slack at once enough for several days, keeping it always covered with water.

The important question is, how much of this mixture is to be employed in the defecation? Upon this depends more than upon any thing else, except good material, the success of the beet sugar manufacturer. No greater mischief, however, can be done, than to teach him to rely upon his scales. The strength of lime varies, and the quality and state of the beet vary with the soil, season, culture, preservation, &c. Any one of these circumstances may be important in determining the quantity of lime. Of forty-three beet sugar manufactories, whose methods we have had an opportunity of observing, no two ever used precisely the same quantity of lime. We found the average quantity to be 250 troy grains to a gallon. Sometimes this would be too much; at others not near enough. Experienced manufacturers never weigh it but judge by the eye, and in the same manner they determine the quantity of water necessary to slack it. Two quarts of water to every pound of lime will make the milk of a proper consistency.

The only safe rule which can be laid down concerning the quantity of lime to be used in the defecation, is *not to put in too much at first*, always remembering that it is easier to supply a deficiency, than to correct an excess. A dose of 150 grains to a gallon will be safe any where, and at all seasons; and two or three hundred grains after the beets have been two months in the pits. On pouring in the milk of lime, the juice should be briskly stirred for a few seconds. The additions, if any, are to be made without stirring, the vessel used for the infusion being held as high as possible, so that its contents may penetrate and mix spontaneously with the whole mass.

To determine when sufficient lime has been added, the following observations may be of service; but we would impress it upon the reader, that nothing but experience will ever enable him to work with tolerable certainty and with satisfaction.

After the first infusion of the milk of lime, if it be insufficient, additions of small and decreasing quantities may be made until the juice begins to be limpid, and a precipitate of a flaky appearance and of a mouse color, is formed in a silver table-spoon. The upper stratum of the liquid will be transparent, and of a pale straw color. A more satisfactory method of examining the effect of the lime, is to throw a spoonful of juice upon a paper filter, placed in a clean wine glass. If the defecation has been good, the juice which passes the filter and appears in the glass, will be clear and of the color above-mentioned; which is sometimes compared to that of amber or of old sherry wine.

The ordinary criterion of the French manufacturers is called *the pellicle*. After the infusion of the lime, and a few moments allowed for it to take effect, a spoonful of juice is taken out and immediately breathed upon. If a thin and delicate skin, resembling ice in the first stage of its formation upon the surface of water, appear in the spoon, it is considered a proof that the dose of lime is sufficient. If the skin be thick and gross, it is proof that the lime is in excess; and if it do not form at all, that more lime is required. Small and prudent additions may be made until the moment of ebullition. At the first sign of this, the steam is commonly shut off, or the fire covered with fine and moistened coal. It is desirable to avoid ebullition, because it renders the settling protracted and imperfect; but there is some advantage in maintaining the heat at boiling point without ebullition some 15 or 20 minutes. This is easily effected, if the heating be by steam, by closing a little more the steam, or opening a little more the waste-cock. If this management be continued during the space above-mentioned, the clarification will be more complete, and the settling not materially retarded. It is not possible thus to humor the heat when the operation is by furnace.

Another sign of a good defecation is a slight emanation of *hartshorn*, perceptible near the surface soon after the infusion of lime. This is quickly gone, and is succeeded by another sign more distinct. Large *flakes* appear swimming and coursing just under the surface. If these grumulations become gross, assuming the appearance of *balls*, rolling and tumbling in the liquid, it is an indication that the lime is in excess and must be neutralized.

All these phenomena, though they cannot be produced without a sufficiency of lime, are consistent with an excess of it; and it becomes important to know what are the signs of such excess.

1. A strong and disagreeable alkaline smell accompanies the juice in the transvasement and filtration.

2. The color grows deep and is but slightly affected

by animal charcoal. It approaches more and more that of strong lye.

3. *In boiling*, scum forms in abundance, and without cessation. Its color becomes a reddish brown, and the taste that of an emulsion.

4. An acid and disagreeable odor arises on stirring.

5. The interior color is a blackish red.

6. The water comes off with such reluctance that 2, 3, and even 8 or 10 hours are occupied in boiling, whereas half or three quarters of an hour ought to be sufficient.

7. The crystalization fails altogether, or is feeble and meagre, and the molasses quits the crystals with extreme reluctance.

To those who would attempt to feel their way in this business, we would observe, that they ought to operate on quantities of juice not exceeding from 1 quart. to 1 gallon; and to be provided with good chemicals. The greatest impediment to success which we know of in this country, is the paragraphs going the rounds, that beet sugar can be made by simple evaporation, in the same manner that maple is, or thar a solution of sugar and water can be reduced to a crystalized or concrete state. This notion is empirical, and can lead to nothing but disappointment. The maple sap comes from the tree elaborated to a good degree by nature; but if instead of being distilled from the tree, the entire trunk were grated and pressed, as is the beet root and the sugar cane, the maple sugar makers would find it a different affair. They would have the same sap, but with it other elements gross and troublesome. The general and strong delusion which exists on this point, may be owing in part to national vanity, which many of our own citizens, and all ambitious and rapacious foreigners, make a *trade* of flattering. The grand chemical problem of manufacturing a white refined sugar from the raw material, at a single operation, has hitherto balked the science and experience of France and the colonies, aided by the most perfect machinery; and yet the American people seem to suppose that "Yankee ingenuity," with a dinner pot and a pudding stick, without any science at all, is going to do it, and produce white refined sugar for 6 cents a pound. We should heartily rejoice if this notion could be realized, but believing it to be imposture, we are desirous that the minds of our countrymen should be disabused and prepared for starting aright.

If the defecation have been good, the juice may be drawn off in a few minutes after the heat is suppressed. But if the solid matters contained in it, are brought by agitation or other cause to an atomic and buoyant state, an hour or more may be necessary for the settling. How this is going on may be seen by inserting carefully a spoon or small ladle, and examining whether, and at what depth, it brings up sediment. Nothing will be gained by hurrying the drawing off, unless the whole be cast into a reservoir, and abandoned to itself until it is clear.

The juice is drawn off through a large cock at the bottom, if it be a steam pan, and through a side cock, if it be a furnace pan. Formerly it was thought best to draw off the *clear* first, and for that purpose to place the cock just above the surface of the usual deposit of sediment; but this varies with the quality of the beets and the skill of the operator. Besides, another cock becomes necessary to take off the deposit. This trouble and expense is avoided by taking off the deposit first. It will all be discharged before the clear begins to arrive at the orifice of the discharging cock.

The reason of placing the defecating pans at a considerable elevation is, that the juice may run from them, and arrive without pumping, or lading, in a reservoir, or in the filters. A movable pipe is attached to the discharging cock, and terminates in the reservoir or filters, and the clear is quickly transferred to the one or the other. We prefer the reservoir, because then, if any deposit is still formed, it may be separated and go with the scum and sediment; and likewise because the admission of the juice into the filters can be better regulated in taking it from a reservoir, than in the hurry of emptying a defecating pan, which may be demanded for a new charge of juice, exposed to injury by every moment's delay.

The sediment, as fast as it is taken off, is thrown into bags of duck, or twilled cotton, one pailful in each. These are deposited in a tub with the mouths twisted, or, what is better, suspended on a wooden horse with a trough underneath. This horse may save the labor of one man, for it is so constructed as to suspend the empty bags, with their mouths distended on all sides ; consequently they may be filled by one man, otherwise two are constantly required. The juice, which distils from them quite clear, being in a considerable degree exhausted, the bags are taken down, laid upon hurdles, the mouths secured by folding, and a pile formed upon a small screw press, devoted to this service. The scum which ought to be abundant, reaches the bottom of the pan as the clear passes off. It is there stirred with a spatule or a birch broom, and flows off like the sediment, and goes into bags and to the press last mentioned.

Many manufacturers ordinarily give their defecating pans no other cleaning than the sweeping above-mentioned ; others dash them at every defecation with two or three pails of water ; but once a week all give them a thorough scouring. The dirty water runs off to the manure heap. Of course good drains are to be prepared under the floor or pavement. If the pression is conducted with discretion, the juice from the scum press is about as pure as any, and the residuum, solid, nearly dry, and very valuable as a manure. It ought to be saved apart from the common dunghill, and used ultimately in powder, like animal black.

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§ 5.

FIRST FILTRATION.

Filtering boxes are usually conical or pyramidal, although any box, tub or cask, which is tight and not less than two feet in height, will answer. They are composed of pine plank, lined with copper, of oak staves without lining, or entirely of stout rolled copper. The prevailing form is the frustum of a cone, the small end of which is made the bottom, and the large end, or base, the top. The diameter of the top is 2 feet, of the bottom, $1\frac{1}{4}$ feet, and the height 3 feet. If it be of oak staves, the material now generally adopted, it is bound with five or six iron hoops, has a strong handle upon each side a little above the middle, a brass cock at the bottom, and a small copper tube inserted in the faucet between the spigot and the box, and extending to the top of the box. This permits the air to escape as the liquid flows in, and it also serves as a blowpipe to expel any obstruction lodged in the faucet. A copper strainer, resting on a considerable number of supports 2 inches long, soldered to the bottom, is fitted to fill a horizontal section of the box 2 inches, (the length of the supports,) from its bottom. This strainer is provided with a handle in the centre on the upper side. It is planted firmly on its supports at the bottom of the box. Over it is spread a hair and woolen, or coarse woolen cloth, whose diameter is two or three inches greater than that of the strainer. Over this again is spread a coarse linen towel, a little larger than the former. Both are nicely smoothed, care being taken to lay the handle flat before spreading the first cloth. These towels should be wet and wrung before they are applied.

We suppose for the present that animal charcoal, or animal black is prepared, and brought to the hand of the manufacturer of sugar. It arrives at the filtering boxes in a moist state, so that if a handful be taken, compressed slightly and dropped, few grains will adhere to the palm and fingers.

One workman presses the borders of the towel against the walls of the filtering box; another deposits with some care a large scoop-shovel full of the black, which the first passes and presses to the borders of the towels, so as to pin them firmly to the walls. This being done around the circumference of the cloths, more black is thrown in, but with care not to disturb the arrangement just described. When the layer is 4 or 5 inches thick, a rammer, resembling a churn-dash without holes, is employed, after first leveling with the hand, to consolidate it. Then another layer is deposited, leveled and rammed, and so on till the animal black rises to the height of 16 or 18 inches. A coarse linen towel, wet and wrung, is spread over it, and another copper strainer without supports laid thereon, perfectly filling like the first, a horizontal section of the box. The borders of the last towel must rise about 2 inches above the strainer. This is a point of importance, for without the precaution, impurities will get among the grains of black, form a jacket around them, and enfeeble or prevent the action of the filter. If the borders are higher, they will fall upon the strainer, and be rather worse than none at all. The purpose of the copper strainer at the top, is to diffuse the liquid equally over the surface, and make it penetrate all parts of the filter alike.

The filter being thus prepared, the juice is permitted to flow into it in a steady current, until it rises an inch or two above the strainer. Then the discharging cock of the filter is opened so far as to emit a stream as large as a pipe-stem. The cock of the reservoir of defecated juice is at the same time so far shut, as just to maintain the height of the liquor in the filter. If, as frequently happens, the juice which first issues from the filter be a little turbid, it is to be repassed until it comes clear.

The filters for the defecated juice should be placed at such an elevation that it will run from them by a tin or copper gutter, or a wooden one lined with zinc, into a reservoir at the evaporating, commonly called the *concentrating pans*. It may however be permitted to run directly into those pans. This is usual if the concentration be by furnace.

The principal object of the filtrations is the decoloration of juices and syrups, but it effects other purposes scarcely less important. It takes up lime, acid and gummous matter. Before the use of animal black was discovered, it was considered impossible to boil the beet syrup over a furnace, by reason of its viscous nature, which rendered it liable to be burned. At first the animal black was used in the form of an impalpable powder, and thrown into the concentrating pans, or used as an agent in the defecation. This mode was objectionable, because the same black could be used only once or twice, and was then thrown away. The substitution of grains in filters for powder in the pans, was an important step. It heightened the effect, as more could be used; it was more convenient and economical. In the granulated state the black can be *revivified*, so that the same may be used indefinitely. We have seen large quantities in different factories which had been in use 10 or 12 years.

An improvement, recently made in the use of these filters, consists in filtering from *bottom to top*. In this way the deposition of scum among the grains, and the necessity of the great difference of levels, in order to have one operation give aliment to another, are avoided.

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§ 6.

EVAPORATION OR CONCENTRATION.

After defecation the juice which previously marked 6° to 8° by the saccharometer, retains a density of only 3° or 4°. This is owing to the separation of the solid matters which have formed the sediment.

The concentrating pans, into which the juice is now to be admitted, are heated by steam or furnaces. In either case they are made with a perfectly flat bottom, and of comparatively little depth. For furnaces they are usually 16 inches in depth, and 4 feet in diameter if round, and 5 or 6 feet by $2\frac{1}{2}$ or 3 feet, if oblong.

The furnaces require a particular construction. The fire is to come in contact with the bottom only, and with the whole of this, except a narrow border at the circumference, which rests on an iron curb, fixed upon the brick-work, and supporting the pan and its charge. The cavity beneath is sometimes single, so that the flames after expanding, escape immediately by a chimney or a flue, where of course they continue some distance, and thus a considerable portion of heat is lost. A better disposition of the furnace is to build with brick, or with an earth which will retain its form and become indurated by fire, a circular or elliptical ridge, rising so high that the bottom of the pan will rest, and when charged, press upon it. This ridge will form an interior furnace. The sides of this interior, and those of the principal furnace, have an interval of $\frac{1}{2}$ to $\frac{3}{4}$ of a foot betwixt them ; the height of which will be coincident with that of the furnace. The segment of the circle or ellipse, forming the interior furnace, is of course open opposite to the mouth of the principal furnace, and this arrangement leaves an orifice on each side of the throat, by which the flames, after exploring the interior furnace and finding no issue, escape. Then, traversing the intervals on each side, in other words, the entire circumference of the pan, they unite, if not exhausted, in a chimney or flue in the rear. This is a powerful and economical furnace.

A few manufacturers have several ordinary chimneys contiguous to their furnaces, but almost all have a single chimney 60 to 80 feet in height, in which any number of flues may unite. This chimney is placed outside of the building, and several feet from it, and is usually round, as the square are liable to be blown down. This chimney gives the best draught, and obviates the inconvenience of smoke and some of the dangers of fire.

Of the models of concentrating furnace pans, the *swivel-pan* is deemed the best. It has a beak or snout in front. Underneath the beak, the bottom is attached by two hinges to a round bar crossing the mouth of the furnace, and fixed. In the rear it has a couple of iron rods, hooked to the edge at two points equidistant from the point opposite the beak. The upper ends of the rods are attached to a single rod, and the latter to the end of a lever, suspended by a chain or rod, attached to a beam or joist above. The other end of the lever is armed with a rope or stirrup, near the station of the workman. A slight force applied to this raises the back part of the pan, while the front turns upon the hinges ; thus the contents are suddenly and completely discharged. The advantage of this pan is that it can be emptied without extinguishing the fire, and without burning the juice or syrup. If the fire be continued under an immovable pan, it will be readily conceived that the thin layer of liquor remaining, when the discharge is nearly complete, must be burned, to the great injury both of the product and of the pan. Not more than 4 or 5 inches of liquor is usually put into a concentrating pan at once.

The most approved steam pan for concentration, is in the form of a rectangle, 12 feet in length, and 2½ to 3 feet in width. Its depth is only 8 inches. The steam circulates in a series of ten parallel pipes, 1½ inches in diameter, resting on the bottom of the pan. The pan, except the pipes, is wood lined with copper. This part is separate from the pipes, and can be depressed to the floor or pavement, or elevated to a contact with the pipes at pleasure. This construction renders it easy to clean both. The end which receives the juice, is a little more raised, and the discharging end a little narrower than the remaining parts. A thin layer of juice, sufficient merely to cover the pipes well, is admitted into this pan through a tin triangular prism, open on the upper side, and pierced at the opposite angle with a great number of small holes. This appendage distributes the liquor uniformly on the bottom of the pan. It traverses the width of the upper or receiving end.

The steam being admitted into the pipes, ebullition takes place almost instantaneously. If the liquor threaten to overpass the sides, a mite of butter is laid upon the skimmer, and this being carried along the surface, the swell immediately subsides. Not more than 60 or 70 grains of butter should be used at a time, and this very sweet. Instead of butter any fatty substance, or milk may be used. We have been told that the maple sugar boilers make use of a thick rind of pork, tied to the end of a stick, which being plunged in the liquid, causes it to subside. The same rind will serve for many boilings. When the juice is so concentrated as to mark 15° by the saccharometer, the discharging cock is opened and one or two receiving cocks, and henceforth the defecated juice is permitted to flow in constantly, and the concentrated juice, at 15°, now called *syrup*, to flow out, being brought to that density in its passage from end to end of the pan. This is called *continued evaporation.* Two such pans do the work of a dozen furnace pans.

There are other models of steam pans for concentration, but it would be tedious and not useful to describe them. Whatever pan is used, or however heated, the ebullition should be kept down until the scum is formed. When this has been removed with the skimmer the evaporation may be pushed.

Upon the first heating of the juice in the concentrating pans, it is to be examined as to its chemical state. For this purpose slips of paper stained with litmus, are dipped in vinegar or any weak acid. The slips from a blue or violet immediately become red, and the red and blue slips together, constitute the chemical test by which the juice is to be examined. If a red slip on being immersed in the liquor, become blue, it shows a predominance of lime. If the red remain unchanged, and the blue becomes red, it shows a predominance of acid. The acid is always to be saturated by slight and prudent additions of lime-water, or of thin milk of lime; but not so the alkali. A little excess of this is deemed advantageous. If it blue the reddened paper pretty distinctly but not deeply, the juice is sufficiently neutral, and may be concentrated without change. If, however, the blue be deep and strong, sulphuric acid, diluted with 8 or 10 times its volume of water, or phosphoric acid, must be added until the trace of lime appears, as we have already described, manifest, but not deep. The use of the blue and red papers will be aided by a third paper, stained with the extract of curcuma root. If this paper on being immersed becomes brown, but is nearly restored to its yellow color by drying, the liquor is right. If, on the contrary, it retains a uniform brown, the proportion of lime has been too great.

Whatever scum may rise during the concentration, is to be taken off, and the juice cleaned as much as possible. All the scums are thrown into a vessel to go into the next defecation.

From the concentrating pans the syrup runs into a reservoir over the second range of filters, or into a reservoir under ground.

The concentrating pans are to be washed every day, and once a week thoroughly scoured. In the last operation a small quantity of sulphuric acid is employed, as the pipes and bottom are apt to become coated with carbonate of lime.

§ 7.

SECOND FILTRATION.

The filter or filters used, and the manner of using them in this manipulation, are precisely such as we have already described. The only difference is the syrupy state at which the juice has now arrived, having been reduced to about ¼ of its original volume. From the second range of filters the syrup passes to a reservoir, placed, if possible, above the pan or pans for the second concentration.

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§ 8.

SECOND CONCENTRATION.

A single pan, though heated by furnace, commonly suffices for this. The pans already described are proper to be used at this stage. The syrup is brought rapidly to 25° by saccharometer. The heat is then suppressed, and the syrup passed to a reservoir placed above the third range of filters. We again remark that it is desirable that this transfer take place by current, and not by decantation.

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§ 9.

THIRD FILTRATION.

This is conducted in all rspects like the preceding ones. From it the syrup runs into a reservoir commonly under ground; but the most experienced manufacturers consider it desirable to have even this last reservoir so situated as of itself to feed the boiler.

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§ 10.

BOILING.

The pan for boiling is smaller than those for concentration and almost always round. The swivel pan is the best for a furnace. For steam a coil of copper pipe reposes upon the bottom, occupying the whole of it except small interstices betwixt the concentric circles. Next to the defecation, the boiling is the most difficult process. It is a severe touchstone of all the preceding operations. If these have all been right, the syrup now appears light and dry, when boiling, is of a fine golden color, and gives out its water readily and without much rising. If on the other hand there is a considerable excess or deficiency of lime, or if the operations have been slow, or any part of the apparatus deficient in cleanliness, the syrup will now be heavy, viscous, abounding in scum and rising often and fiercely to the top of the boiler.

To the experienced manufacturer the aspect of the syrup in the pan will indicate the approach of the degree of density at which it will granulate, or become sugar. Then he takes the *proof.* To this end the skimmer is plunged in the syrup, withdrawn and slightly shaken. The thumb is then applied to it and passed along an inch or two of its surface, and the forefinger closed upon the drop, which adheres to the thumb. The thumb and finger are then separated briskly, and if the boiling is sufficient a fine *thread* several inches in length will be drawn out, and on giving the thumb a quick horizontal motion towards the palm, the thread will break at the thumb, and contracting gently towards the finger, will assume the appearance of a corkscrew, and nearly cease to retreat at about ¼ of an inch from the finger. Upon these appearances the heat is suppressed, and the syrup transported to the cooler.

A second mode of proof is by the *bubbles.* The skimmer is plunged in the syrup, withdrawn and shaken. The master of the boiling then blows smartly on one side. If a number of delicate white bubbles issue from the opposite side, and fall in a shower, the boiling is sufficient. If none or very few are formed, it must be continued. Instead of blowing, a similar effect may be produced by flirting the skimmer, the concave side foremost in the air.

The saccharometer will also indicate, though with less certainty, the point of granulation. For rich and pure syrups 40° of this instrument are sufficient, and from that to 44° for inferior.

The thermometer may be employed in the same service. The density of boiling liquids is always in direct proportion to their heat. The bulb of the thermometer being immersed in the syrup, the mercury will continue to rise as the density increases. When it has been ascertained by experiments to what point the mercury rises in syrup brought to the precise point for a good granulation, a mark on the scale will fix that point, and the instrument may be safely used for subsequent boilings of like syrup. The point will vary with the nature and quality of the material, and the celerity and skill of the operations. It follows that the same mark will not answer, unless there is considerable uniformity in these particulars.

Neither of these instruments are much employed in boiling the beet syrups, which generally contain more or less of other soluble matters besides sugar. These influence equally with sugar, the indications of the instruments. They serve better for refiners who operate upon syrups, which are more nearly pure solutions of sugar and water. They may aid beginners. There is no harm in trying all the modes of proof upon one and the same boiling. The proof by the thread, or bubbles, or both together, is that on which manufacturers ultimately and generally rely.

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§ 11

FILLING.

The cooler is a copper cylindrical basin, larger and deeper than the concentrating pans, or the boiler. It is raised above the floor or pavement in order that the air may circulate around it. This is effected by placing a stout wreath of straw beneath it, or, still better, by suspending it by gudgeons fixed firmly to the sides, on two posts. This is an excellent arrangement, because it admits of tipping the vessel after it has been exhausted by the ladle. This is done by means of a handle on the backside. A beak in front facilitates the operation.

It is usual to charge the cooler with several successive boilings. By this means, if one boiling has been too close and another not sufficiently so, the mass, when mixed, acquires a medium density, and all errors are rectified. It must be stirred from time to time with a spatule or ladle.

At night, or sooner if necessary, the filling takes place. In any event the temperature of the cooler should not be suffered to fall below 145° to 165°. The moulds, called *bastards*, have generally more or less grains attached to their sides from previous use. They are stopped at their points by screwing in cotton or linen rags. They are then established on their points in an upright position against the wall. Other moulds or pots are placed in close contact to secure them in position. One workman, holding a basin with a long beak, places himself by the side of the coolor. Another with a ladle, having a long handle, and resembling a warming-pan without the lid, stirs the syrup by plunging the implement in it, and sweeping it twice or thrice around the vessel. He then lades into the basin, which being filled, is as much as the workman charged with it can conveniently carry. He removes it to the range of moulds, and casts it, in about equal quantities, into five or six. These operations are repeated until all the moulds are filled. After a little practice, the number of these requisite for a charge of syrup, is readily determined by its height in the cooler. The entire filling is not effected without going the rounds of all the moulds several times. The reason of this is that the grain which has begun to form in the cooler, settles to the bottom, and is more abundant towards the last of the filling than it was at first. It is an object to divide it as equally as may be, among all the moulds.

The filling being completed the moulds are abandoned for a time to themselves in the filling room, which is always kept at a temperature of 70° to 75°. In a few hours grains are formed about the walls of the moulds. They are then to be stirred or ***hauled***. A bit of lath, longer than the moulds, and with ends and edges square except the corners of the lower end and the sides, where it is grasped by the hand, is thrust down the walls, scraping off the grains. This being done around the entire circumference, a rotary motion of the instrument gathers the grain into a nucleus about the axis of the cone. In 10 or 12 hours the granulation is complete, the sugar is hard with a slight depression or slump in the centre, which is a sign that the just point was attained in the boiling. If this do not appear, it is a proof that the boiling was too close. If the mass remain in the state of fluid or pap, it is proof that the boiling was insufficient, or that the syrup contains matters, or has undergone a change which prevents crystalization.

Instead of earthern moulds, wooden ones, costing no more, containing much more and lasting much longer, are sometimes used. They must, however, be first baked, and the hoops driven, otherwise the syrup will escape, and according to Mr. Dombasle, derange and defeat the process of crystalization, so that it becomes necessary to melt the mass and reboil it. Mr. Payen has proposed wooden moulds, or rather crystalizers, in the form of a hopper, capable of containing 3 or 400 pounds, lined with copper or lead, and resting on three supports in such a manner that they can be tipped, pivoting on the centre support. In this way the drainage may be completed.

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§ 12.

THE CURING ROOM.

The granulation being complete, the moulds are carried between two batoons connected by a rope, to the curing room. They are there placed on pots, or, what is better, on low wooden horses, covered with a flooring, in which circular holes are cut at proper distances to receive the points of the moulds. These distances, including the semidiameters of the holes, should be equal to the diameter of the top of the moulds. The moulds are unstopped and placed firmly in the holes. A gutter under each row receives the molasses and conveys it to a large common pipe or gutter, which again conveys it to a reservoir in a cool apartment below. The heat of the curing room is maintained at 80° to 90°. In 10 or 12 days, this heat being constant, the moulds are removed to an apartment above, called the hot-house, (etuve,) where the drainage is completed in a few days, and the sugar taken out. When taken out, it is beat upon a platform, so as to break the lumps, and then spread in a large bin where each successive layer dries. A large mass being accumulated, it is put up in bags or casks for the market, and removed to the store-room. Sparrels, scrapers and small cone-shaped spades are ordinarily used to take out the sugar. A machine has been invented in France by Mr. Clemandot, a manufacturer at Beaumetz, near Arras, which executes this work with great ease and economy.

It is upon the principle of the auger. By adjusting the borer to the shape of the moulds, the sugar is taken out very clean, and in a crushed state.

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§ 13.

REBOILING OF MOLASSES.

All the manufacturers of beet sugar reboil their molasses once, and many of them twice. Preparatory to this, it is diluted either with water, or, what is better, with fresh juice, until it marks 25° by the saccharometer. It is then heated to 170°, and 4 or 5 per cent of powdered animal charcoal added, and well stirred in. When the heat has reached 190°, 3 or 4 per cent of skimmed milk is poured in and thoroughly mixed. The heat arrives gradually at the boiling point, and may be advantageously entertained there, but without boiling, for some little time. When the liquor, examined in a spoon, appears quite clear, the heat is suppressed, and in a few minutes the clear liquor drawn off. The scum remains at the bottom of the pan. A little water is poured upon it, the whole well stirred, and thrown upon a filter where it is suffered to drain, and pass with the rest. The whole being filtered, is boiled in the manner heretofore described, except that it is brought to a higher degree of density. The sugar formed from this syrup is scarcely inferior to that of the first crystalization ; and the molasses, which drains from it, may be treated in its turn in the same way, and another deposit of inferior sugar be obtained.

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§ 14.

REVIVIFICATION OF ANIMAL CHARCOAL.

The decoloring power of the filters diminishes at every filtration until it ceases altogether. This will take place after they have been filled 6 or 8 times. The filters used for syrup at 25°, are removed after two filtrations to the range for syrup at 15°, and thence after two filtrations, to the range for defecated juice. In this way the syrup adhering to the charcoal is washed off and saved. After being filled twice or more with defecated juice, the filters are passed to the wash-tub and emptied.

The animal charcoal, called also animal carbon, animal black, ivory black and bone black, arrives at the wash-tub, charged with various matters, of which it has deprived the syrup and juice, which have been in contact with it. The separation of these matters, and the restoration of the charcoal to its original purity and power, is what is meant by *revivification.* The first step is to wash it ; many do this with pure water, but it is done more effectually with acidulated water. In France muriatic acid is employed, 1 gill being diluted with a pailful of water. This is thrown upon 2 bushels of black and the whole well stirred. Water is added until the mass is saturated, and then it is stirred a good quarter of an hour. Hot water is preferable for this purpose. Some have a separate boiler, near the kiln, expressly for this purpose. If steam is used, the waste water will answer. The acidulated water having taken effect, is decanted, or runs off by a cock into the drain, and the charcoal is then rinsed until the water comes off perfectly clear. The black is then dried, usually upon a sheet-iron table, under which a flue passes. A more economical method is to spread it upon the top of the kiln for the recalcination, as the drying is then effected without additional fuel. Being dry, it is put into iron crucibles containing 3 gallons. These are usually of cast-iron, in the form of a dinner pot without the legs, and so adapted that the bottom of one closes the mouth of another. Four or five tiers of these crucibles are piled in a capacious kiln. Those forming the last tier are covered with lids. The crucible may be made of stout sheet-iron, 15 inches high and 10 inches in diameter. These will last a good while, and are in some respects preferable to cast-iron. The latter, however, are in general use.

The kiln, or oven, is of a capacity to contain some 60 or 70 crucibles. It is constructed with a powerful furnace under its whole area. The top of the furnace, which is in fact the bottom of the kiln, consists of a series of arches in the form of a grate or gridiron, the bars being of brick 8 or 9 inches wide, and the intervals betwixt them 3 or 4 inches. These arches have a wide spring, so that a level floor may be obtained in the interior without essentially varying its thickness. The crucibles are placed upon the arches or bars in such a manner that the fire, rising through their intervals, readily pervades the pile.

The transportation of the crucibles to their destined place, and their arrangement there, require an easy ingress and egress of the kiln. For this purpose a man-hole, which can be entered with a little stooping, is left in one side. After the charge is in, this is closed either by laying up bricks with clay mortar, or by a stout iron door, shutting very closely, and barred outside in the manner of shop windows; the bars are iron, and so fashioned with their staples and hooks, as to press with considerable force upon the door. The fire being lighted, the pile of crucibles is soon brought to a red heat, at which it is maintained during 4 hours. A small round hole through the wall of the kiln, closed by a sheet-iron tompion, enables the workman to examine from time to time the state of the interior. The recalcination being accomplished, the fire is extinguished or suffered to expire, and the door opened. When the heat has subsided so that a workman can enter without inconvenience, the crucibles are taken out and emptied into a bin, or a heap, where the article remains ready for use.

There are other modes of recalcining animal black. One is to expose it to a red heat on a sheet-iron table with raised borders. In this situation it is constantly stirred with a rake. As fast as it becomes entirely red it is poked into a tub of water, from which it is passed to the bin.

A third and very excellent method is by the *kiln of columns.* This is a large, square, brick structure, 7 feet high, 3½ feet in front, and 4 feet from front to rear.

Within, and directly over the furnace, are placed in a vertical position, 4 hollow columns of cast iron, 4½ feet long, and 6 to 8 inches in diameter. The walls of the columns are 1 inch thick. They rest upon iron plates, pierced with holes of the same diameter as the hollow of the columns, one plate to two columns. The columns are cut on the outsides, right and left, so as to permit four registers to slide upon the plates, and to open and shut the cavities of the columns at pleasure. Beneath each hole in the plates, is set in the solid masonry, a sheet-iron hopper, debouching externally on the right and left, and shut at the lower extremity with sheet-iron tompions. The columns are cast *in Siamese twins*, each two being about 4 inches apart and about the same distance from the walls of the kiln. The bars uniting two columns, are intended to be a mutual support, because the intensity of the heat has caused the columns to sway and collapse. The distance between the pairs of columns is ½ a foot. The tops of the columns are stopped by cast iron tompions, sometimes secured by screws, but their weight, 18 or 20 lbs., is sufficient to keep them in place. On the top of the kiln is a sheet-iron platform, which by adding a slight rim, may be made a convenient place for drying the black preparatory to the recalcination. It will be readily perceived that the black can be conveniently raked from the platform into the cavities of the columns, provided the latter are placed a trifle lower than the upper surface of the iron platform. The furnace is beneath the columns, the flame ascends beneath and around them, and is detained and diffused by a diaphragm. The columns being filled and stopped, and the fire kindled, they are soon brought to a red heat. In two hours the work is done. The registers are then opened, and the black, now at a red heat, falls into the iron hoppers, and the columns are again charged. The tompions are then taken out of the lower end of the hoppers, and the black received into large iron buckets, where it cools and is carried to the heap.

The only objection which we know to the kiln of columns is the danger of melting. On account of this, some manufacturers have exchanged them for the crucibles. Of late it has been improved by placing an iron bar in the axis of each column. This being a better conductor of heat than the grains of the black, has added considerably to the efficiency of the apparatus. The walls of these kilns of both kinds are 2 or 3 feet thick, and strongly keyed.

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§ 15.

MANUFACTURE OF ANIMAL CHARCOAL.

Manufacturers must revivify their black, and they *can* make it. For this purpose they use the kilns and crucibles already described.

Any bones will answer for making animal black, but the solidest are the best, and the spongy and porous the worst. If they have lain many years in the fields, their value is much diminished. If they are greasy they must be boiled. The manufacturers of animal black make a little profit by collecting the grease and disposing of it to the soap-boilers. If any flesh or sinews remain, they are to be removed. The bones are cracked with a heavy hammer so as to lie compactly in the crucibles. These are then placed one atop of another, as in recalcining, and the joint luted, so as to exclude the atmospheric air. If the man-hole be closed by a door this is also luted. Dry wood is disposed among the crucibles, where there is room for it; though this may be dispensed with. If, however, there is any doubt of making the heat sufficiently intense and uniform, and this without much delay, the wood ought to be added. The fire being kindled and the crucibles brought to a red heat, a variety of gases escape through the fissures of the clay. These are mostly consumed on issuing from the crucibles, and serve to augment the heat. But they may be preserved by conducting them to gasometers, or into heaps of earth, which they convert into a valuable manure. The water in which bones are boiled to deprive them of grease is likewise a useful manure. In 12 to 15 hours, if the fire be kept up, the work is done. The kiln is opened, and when the heat has subsibed, the crucibles are removed. Care must be taken not to open them before the fire within is extinguished. It has sometimes happened, for want of this precaution, that on being exposed to the air they have burned with a bright flame. This is very mischievous. The remedy is to deluge them with water.

If the operation has been good, the bones come out a deep, rich black, and without taste or smell. If air has had access, they are perfectly white and worthless except for manure. If they have not had sufficient heat, they are of a reddish brown. Such are thrown aside to be put in the next batch.

The manufacture may be well combined with the revivification of animal black. The crucibles are first filled with cracked bones; grains to be recalcined are then thrown and shaken into the interstices. The crucibles are then proceed-ed with as before described. Both bones and grains come out rather better for this union.

The same thing can be done in the columns, except that the bones and grains must be deposited in successive layers.

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§ 16.

MISCELLANEOUS OBSERVATIONS:

The most important general rules which can be laid down, relate to cleanliness and despatch. All the vessels, utensils and machines are to be kept as clean as the vessels and instruments of a dairy. The hurdles, sacks and towels are to be washed in hot water every 12 hours, and the two latter to be boiled once in 24 hours. It is also important that the floor or pavement of the workshop be kept clean, and the atmosphere pure, and as cool as possible. The atmospheric air in its best state is prejudicial to the juice; but when charged with exhalations from filth and fermentation, its destructive energies are vastly augmented. Dryness and coolness are desirable. The hot vapor arising from the pans is mostly confined by covers, and conducted by flues out at the roof or walls of the building.

It is generally considered that 4 hours is as much as ought to be allowed to intervene between the grating of the beet and the filling of the moulds. But it is admitted on all hands to be highly desirable to reduce this period, and to this end the efforts of individuals and societies in France are diligently directed. That arrangement of the works, already repeatedly alluded to, by which one part or process supplies aliment spontaneously to the next, ought to be adopted if the building will possibly admit of it. This not only gives celerity to the work, but it saves lading, pumping and decantation, which are laborious as well as injurious.

EXPLANATION OF PLATE.

The Workshop, [Figs. 5 and 5′] represents such an arrangement of the works as we have recommended. The height here assumed is 25 feet, and the length 50 feet. It is divided into two compartments, one of which [Fig. 5] is occupied by the horse power, windlass, grater and presses, and the other [Fig. 5′] by the pans, filters, reservoirs and cooler. The heating is supposed to be by steam, but the same plan would answer if the pans were to be provided with furnaces.

The Saccharometer has a ballast of robin shot in the lower bulb. This sinks it to 0 in *water*. In proportion as the density of the liquid is greater than water, the instrument rises out of it to 5, 10, 15, &c., or to some of the intermediate degrees, marked in the figure by *points*. The *basin* has a long beak, designed for pouring the syrup brought to the crystallizing point (about 40°) into the moulds. The *ladle* is used for stirring the syrup in the cooler, and filling the basin.

A. Horse-power, giving motion to B, windlass for hoisting the beets; to C, the Grater; and to D D, the Hydrostatic presses,

The washing machine is not represented, but is turned by the same mover.

a. a. Pumps for working the presses.

E. Defecating pans; one only of the battery or range, consisting of two or three, being represented.

F. Ivory black filters.

G. Concentrating pans.

H. Second filters.

I. Reservoir of syrup at 25°.

J. Boiling pan.

K. Cooler.

Fig. 6. Saccharometer, ½ foot long.

Fig. 7. Ladle, 5 feet long.

Fig. 8. Basin, 2 feet long.

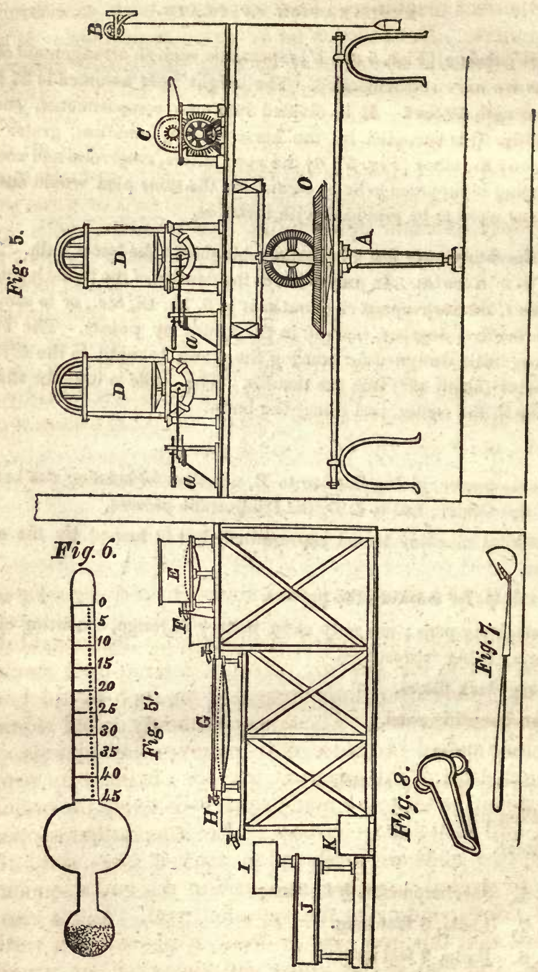
Fig. 5.
Fig. 5'.
Fig. 6.
Fig. 7.
Fig. 8.
A
B
C
D
D
O
a
a
E
F
G
H
I
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10
15
20
25
30
35
40
45

The delays incident to experiments with insufficient hands, and imperfect machinery, lead to results very discouraging to beginners. But there is no occasion to despair. It may be found that the obstacles to success are easily removed. Perseverance, redoubled attention to cleanliness, and redoubled diligence in executing all the processes, will finally enable the intelligent manufacturer to triumph over all difficulties, and arrive at what the French call, *l'aplomb manufacturier*. It is considered by them that two or three years is necessary to attain this even in their country, with good material, experienced workmen, and the most perfect machinery. In a work published in 1836, Mr. Dombasle declares that two years are necessary in the very focus of the French beet-sugar manufacture, *for getting under weigh*. Nearly all the early cotton factories failed in this country, though we leaped into the business matured by the improvements of two hundred years. The Louisiana sugaries make no profits the first 3 or 4 years.

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§ 17.

THE DOMBASLE, OR MACERATING SYSTEM.

A considerable number of manufactories are established in France upon this system. The beet is cut by a machine called the *root-cutter*, into slices $\frac{1}{8}$ of an inch in thickness, and $\frac{1}{2}$ an inch in width. These are commonly called *ribands*. A machine called *the macerator* receives the ribands. A competent idea of this machine may be obtained by supposing a steam boiler to be made *square*, of twice the ordinary length, and bent like an ox-bow. Let it be further supposed that the two ends are produced in curved lines until they meet, are riveted together, and form at this end a semicircle or arch, corresponding to the opposite bend. Let it also be supposed that this iron case or drum, is placed in a vertical position, and that at the upper end, the outer, or superior, and inner or inferior sides of the arch, are cut out, leaving the two faces entire; so that if a body were dropped from the central point of the upper arch within the two remaining sides, it would fall through the length of the case or drum until it lodged on the interior surface of the lower arch or bend.

The case, being 16 to 20 feet in length, occupies the whole of one story and part of another. On the open end is mounted a pair of rag wheels, fixed on a common axle, over each of which passes an endless chain, traversing the circuit of the cavity of the case. To every foot of these chains is fixed a hurdle of iron rods, called in France a *palette*, large enough to fill, but without friction, a horizontal section of the cavity. These are maintained in a horizontal position by iron braces, except when they pass the arches or bends, and then they assume, first, an oblique position, then a vertical, then an oblique, and, lastly, resume again the horizontal. From all this it will be apparent that a movement of the rag wheels, which is effected by a crank or a cross-head, must depress the palettes on one side and raise them on the other.

The case is filled with boiling water from a reservoir near the head, and communicating by a pipe, a couple of connecting cocks, and a small vessel adjusted between the cocks. On the side opposite to the reservoir, is a hopper terminating precisely upon the palettes as they successively come round. Into this hopper is cast 30 or 40 pounds of ribands, which slide upon the palette, then in a position to receive them. A slight movement of the rag wheels plunges this palette with its charge into the water, and brings an empty palette to its place under the hopper. This again is charged and another turn given, and so on. When the chains have made the circuit of the cavity, all the palettes have been charged and plunged. The first one charged, has been in during the whole time of the operation, and has now arrived in a position where itself and two or three of its nearest successors have discharged their burdens. The time occupied is supposed to be one hour, though it is often less. The ribands, which have been in hot water during that space, are deprived of most of their saccharine. As the palettes arrive at a vertical position at the top, the exhausted ribands are discharged by their own weight upon an inclined plane, which intercepts their fall towards the lower bend of the case, and conveys them out of the building, or into another apartment, at the pleasure of the proprietor. Of course the emptied palette immediately presents itself under the hopper to receive another charge, and to set out out on a new journey. When the water has become sufficiently rich in saccharine, which is from 4° to 6° according to the state and quality of the beets, a certain quantity of boiling water is let in from the reservoir at every new charge of ribands. The proportion is generally 6 ounces of water to 1 pound of ribands. The water is measured in the small vessel before mentioned. By opening the cock between this and the reservoir, it is filled; by opening the cock between this and the case, it is emptied into the case. And now the liquor begins to flow from the case by a conduit on the side opposite the reservoir, to the defecating pan; and thus it continues to flow night and day until the manufacturing season is over, unless it is stopped on Sundays and holidays, which it rarely is in France. There must of course be two defecating pans at least. When it is desired to suspend the work, the case is emptied by a cock inserted at the lowest point of the lower bend. Two steam pipes enter the branches of the case near the bottom, and infuse steam into the liquor at the pleasure of the operator, for the purpose of keeping up the heat; but it is thought that this object would be effected more advantageously by circulation than by infusion. The condensed water weakens the liquor, and deprives the operator of the control of the proportion of water and sugar. After the liquor or juice has arrived at the defecating pans, its treatment is no other than that which has been described in the system of grating and pressing. The only difference is that a little less lime is employed upon the liquor coming from the macerator than upon the natural juice. In the manufactories with which we are acquainted, we have found this difference about $\frac{2}{5}$.

The method of maceration is supposed to give rather more and better sugar than that of grating and pressing. But its principal and undoubted advantage is, that it saves

30 or 40 per cent of labor. Its disadvantages are, that it consumes more fuel, and that the pulp is less valuable for feeding. It is used for that purpose, but it contains too much water to fat or nourish animals as well as the pulp of the press ; but upon the whole we are of opinion that, in most localities in this country, the balance would incline in its favor. In the interior, and the new States, fuel is very cheap and labor very dear. These two facts are in our opinion decisive as it respects those States. In other States it would probably be found not less profitable than the old system. The refiners generally prefer the sugar of the macerator.

Mr. Dombasle, the inventor of the system, used and recommended a series of tubs or basins, filled with slices of beet and boiling water, in which the heat was kept up by steam or by furnaces. The tubs are constructed with false bottoms perforated, and are placed on planes commanding one another. When the water put in one has taken effect, it is passed to another filled in like manner with slices of beet; and thus it goes on until the liquor has acquired a sufficient degree of saccharine richness on the one hand, and the material is deprived of it on the other. Neither of these results can ever be theoretically perfect, though sufficiently so for practical purposes. The law which governs the operation is, that a body immersed in water will retain the same proportion of its soluble matter as it imparts to the water. Thus, if there be 8° of saccharine in the beet, it will retain 4° and the water will receive 4°. Immerse the same slices in new water and they will retain 2° and impart 2°; at the next immersion or maceration, it will be 1° each, and at the next ½°, which is as far as it is worth while to carry the process. Of course the richest juice will be 7½ if the natural juice be 8°; and the most exhausted pulp will retain ½°. The series of tubs is 6 to 8. This apparatus has been highly recommended as cheap and convenient for small farmers.

§ 18.

EXPENSE OF THE MANUFACTURE.

In France the economical question as it relates to the foregoing methods, has been settled by manifold experience. According to the earliest actual accounts of the cost of the manufacture in that country, the pound of raw sugar of the beet, costs 16 *cents*. *Mr. Drapiez*, of Lille, in the year 1811, made the cost of refined beet sugar 35 *cents*, and *Mr. Dombasle*, 2 or 3 years afterwards, 30 *cents*. *Count Chaptal*, in 1822 stated the cost of the raw sugar made in his factory at Chauteloupe, at 12 *cents* a pound. In the same year the Duke of Ragusa (*Marmont.*) manufactured it at Chattillon sur Seine, at 9½ *cents*, and *Mr. Crespel*, of Arras, a 6½, which in 1825 he had further reduced to 5½ *cents* per pound. The following are the items of Crespel's account as furnished by him to Mr. Dubrunfaut in that year.

Expenses.

2204 lbs. beets	$2 85
Labor	2 28
Other expenses	2 28
Total . . .	$7 41

Products.

Sugar at 5 per cent. 110 lbs. .	$——
88 lbs. molasses at 70 cents 100 lbs.	61
661 " pulp " 13 " " "	85
Deduct value of pulp and molasses from expenses.	$1 46
Remains	$5 95

Which divided by 110 gives for the cost, per pound, 5 *cents and* 4 *mills*.

In 1831 a medal was awarded by the Society of Encouragement at Paris for the following account by Mr. *Dardant Majambost*, of Limoges. This gentleman has been very successful, having by the culture of the beet and the manufacture of beet sugar, retrieved his affairs from a ruinous condition, into which they had been brought by failure in another branch of manufacture.

Expenses.

1,102,000 lbs. beets at $2 71 per ton	$1,493 21
Mr. Dardant works up 6 to 6½ tons per day, thus 91 days will be necessary for the campaign; 18 men at 19 cents, 5 women at 11½ cents, 4 children at 4¾, and $1,14 for night work, is 5,32 per day, and for 91 days . .	484 12
Fuel	1,102 76
18 oxen for moving the machinery .	155 61
Lime, blood, tubs, hurdles, lights, &c. .	133 00
Interest on fixed capital, and wear of machinery, at 10 per cent . . .	684 00
Interest on floating capital . .	95 00
Gratuities, and carting beets from pits .	171 00
Rent of buildings	114 00
Total	$4,432 70

Products.

Mr. Dardant obtains 5½ per cent. which gives on 1,102,000 lbs. of beets, 60,610 lbs. of sugar, of which 41,876 lbs. at 12.9 cents, is . . .	5,402 00
18,734 lbs. at 8.2m	1,556 68
139 tons 1500 lbs. pulp at $2,71, (consumed on the premises) . . .	371 27
Molasses	304 00
Animal black, to be revivified, or used as manure	57 00
Total . . .	$7,690 95
Deduct expenses . . .	4,432 70
Remains, net profit	$3,258 25
The expenses being reduced by the deduction of the value of pulp and molasses, we have	$3,700 43,

which divided by 60,610 gives 6 *cents* 1 *mill* as the cost of the pound of sugar.

In 1837 Mr. Crespel, in giving evidence before a committee of the Chamber of Deputies, on the beet sugar excise bill, stated the cost of his sugar at 5 *cents* 1 *mill* per pound.

Mr. Clement des Ormes, professor of chemistry, applied to agriculture and the arts, in the *Conservatory of Arts and Trades at Paris*, testified before a previous committee that the average cost of making a pound of beet sugar in France was 5 *cents and* 6 *mills*. This gentleman makes all his inductions with such profoundness and fidelity as to command universal confidence.

Professor *Dumas*, of the *Polytechnic School*, submitted to the same committee the following formula of a beet sugar manufacturing account.

Expenses—

Of manufacturing 220,400 lbs. of beet sugar.

4,408,000 lbs. beets at $2,75 per ton		$6,078 00
Labor, 7200 days at 23⅔c. (25 sous) ·		1,710 00
Coal, 382½ chaldrons at $3,77½ ·		1,424 81
Animal charcoal and other chemical agents · · · · ·		1,235 00
Interest on a fixed capital of $19,000 at 10 per cent. · · · ·		1,900 00
Interest on a floating capital of $9,000 at 6 per cent. · · · ·		570 00
Miscellaneous expenses, light, insurance, repairs, taxes, &c. · · ·		1,425 00
Total · · ·		$14,342 81
Deduct 110,200 lbs. of molasses at 25c. the 100 lbs. · ·	285 41	
881,600 lbs. pulp at 8⅔c. the 100 lbs. · · · ·	759 93	
		1,045 34
Remains · · · · ·		$13,297 47,

which divided by 220,400, gives the cost per pound, viz: 6 *cents.*

We have compared the results of twenty-nine French factories, and found the cost of their sugar 6 *cents* 6 *mills.*

It must be observed that none of these accounts embrace any of the following benefits.

1. The use of the green leaves for feeding a large stock of cattle and sheep during two or three months after the manufacturing begins; or the value of the same leaves left on the field and ploughed in, being in that way worth ½ or ¼ of a manuring, say 5 to 10 loads to the acre.

2. The manure, which is quadrupled in quantity, and improved in quality on a farm, where a beet sugar mill is erected.

3. The great abundance and value of other crops in consequence of that cleaning and pulverizing of the soil, which the beet culture effects.

4. The trimmings of the beets preparatory to submitting them to the grater or root-cutter. Chaptal considers the daily trimmings of 12,000 lbs. of beets sufficient food for 25 or 30 swine. 30,000 lbs. a day, a less quantity than the French factories ordinarily work up, will afford trimmings to feed 60 or 70 swine.

Estimate—

For a beet-sugar factory in the United States on either of the ordinarry French systems, capable of making 300,000 lbs. of sugar in six months, from the first of August to the first of February.

Expenses.

3000 tons beets, raised on the farm at $2,00 exclusive of rent	6,000 00
Labor in the factory, 10,524 days-work, at 75*c.*	7,893 00
Fuel, 500 cords, at $2	1,000 00
40,000 lbs. bones for manufacturing animal black, at ½*c.*	200 00
Lime, acid, &c.	100 00
Lighting, insurance, taxes, and repairs.	600 00

Superintendence and book-keeping .	2,000 00
Interest on capital invested in land, buildings, machinery, and utensils . .	2,000 00
Interest on floating capital . .	1,067 58
Contingencies	1,000 00
Total . .	$21,860 58
Products.	
300,000 lbs. sugar at 6c. . . .	18,000 00
Pulp and molasses, consumed on premises	5,000 00
Total . .	$23,000 00
Deduct expenses . . .	21,860 58
Remains, net profit . . .	$1,139 42

Deducting from the expenses, the value of the pulp and molasses, we have, $16,858,58, which divided by 300,000, gives 5⅔ cents as the estimated cost of a pound of beet sugar, manufactured on either of the old French plans in the United States.

The pulp of a factory working upon the above scale, would be upwards of 10,000 lbs. per day, sufficient to feed 100 bullocks, and 600 sheep, and the trimmings and remnant of pulp 100 swine.

Although labor is much dearer in the United States than in France, yet rent and fuel would be so much cheaper in most localities as to balance it.

§ 19

THE MANUFACTURE OF BEET SUGAR AT NORTHAMPTON, MASS.

An experimental establishment, founded upon the principle of the *dessication* of the beet, was set up at Northampton during the last winter and spring. This principle was first successfully applied by *Mr. Schuzenbach,* a chemist of Carlsruhe in the Grand Duchy of Baden; but the idea of slicing and drying the beet, both as a means of securing its preservation, and facilitating the extraction of its saccharine matter, is old. *Margraff*, the discoverer of beet sugar, dried and pulverized his beet, before submitting it to the action of the solvent by which he obtained the sugar. Thirty years ago Mr. Dombasle dried beets by a moderate heat, and succeeded in completely depriving them of their saccharine, but doubted whether the process could be used for manufacturing purposes. He was led, however, by his experiments in this line to the discovery of the method, since known by his name and by that of *maceration.*

Mr. Toursel, an apothecary of Arras, essayed more recently the dessication of the beet by a high heat, and obtained good results in a small way. *Mr. Nosarewski*, a Polander, resident in France, proposed in 1829 to dry the beet in the open air either entire, or cut transversely in pieces 4 inches thick, to preserve them in this condition, and submit them to the heat of a hot-house, before grinding them to flour. In all these instances the sugar was extracted or displaced by water or by alcohol.

The improvement of Mr. Schuzenbach, so far as it is known to us, consists in the pulverization of the beet, and in the superior expedition and economy with which he effects the dessication.

A method has been patented by Mr. Herd, of Stoneham, near Boston, of drying the beet by a cold blast, in other words, by freezing it dry. This is an ingenious conception, but we are not convinced that it can be made available as a method of manufacture.

The experiment at Northampton is an attempt to carry out the principle of dessication by machinery, contrived by us for the purpose, Mr. Schuzenbach having declined to impart any information unless the privilege of using his invention in the whole United States, were previously purchased and security given for the payment, in case the truth of his pretensions should be demonstrated by the results of a model factory. Therefore, in stating the results, which we have obtained, we do not implicate the system of Mr. Schuzenbach, not knowing what his apparatus or processes are, but pursuing the same principle, by ways and means of our own. We have dried the beet in a kiln of small dimensions, by establishing therein a current of air, heated from 150° to 185°, and equalized by a diaphragm, pierced with holes. By this means we were able to dry 800 lbs. in 24 hours. The material having been cut into fritters ¼ of an inch thick by a machine, is placed above the diaphragm in boxes, having wire gauze bottoms.

For the purpose of pulverizing the dried beet, we have used, first a small cylinder set with diamond headed nails, and turning upon an inclined plane sheathed with iron; and, secondly, a coffee-mill upon the common principle.

The powder, about as fine as ground coffee, is deposited in a tub, and cold water introduced in the proportion of 3 lbs. to 1 lb. of powder. This gives a liquor nearly twice as rich as the natural juice of the beet, and just about as rich as that of the sugar-cane. This liquor contains 1¼ to 1½ pounds of sugar to the gallon. In 20 minutes the sugar is dissolved. The whole is then thrown into sacks 8 lbs. to a sack, or so as to be 1½ inches thick when leveled in the sack. The sacks must be made of some very closely woven fabric. Of various materials, which we have tried, twilled cotton alone has answered the purpose perfectly. The sacks are arranged alternately with osier hurdles, in the same manner as those filled with green pulp in France. One pression with a hydrostatic press, would be sufficient to exhaust the pulp; but having only a screw press, worked by hand, we have found is necessary to press twice, moistening the pulp between the pressions. At the second pression the liquor stands at 7° to 9° by the saccharometer, instead of 10° to 12° as in the first instance.

The defecating pan contains 30 gallons, and is usually charged with 25 gallons. It is heated by steam. The defecation is operated as in the natural juice, except that the proportion of lime is greater. The smallest which we have found sufficient, is 300 grains to a gallon of liquor. The subsequent operations are essentially the same as in the

French sugar-houses. For the purpose, however, of economizing the animal black, for making and revivifying which our apparatus is small, we filter but twice, viz. first the defecated juice, and secondly the syrup at 20°. The concentrating pan is heated by steam, circulating, as in the defecating pan, through a series of pipes.

We have constantly obtained from 7 to 10½ pounds of saccharine to 100 pounds of green beet, or to 14 lbs. of dry. These products included the molasses, which has varied from ⅓ to ¾ of the whole. The unusual proportion of molasses resulting in some instances, has been owing to injury, which the beets received by frost and decay before the drying, or by smoke and burning during that process. Frost does not of itself injure the sugar of the beet, but on the contrary facilitates its extraction, and increases its purity; yet, as soon as the root begins to thaw, the destruction of its crystalizable sugar, sets in with frightful rapidity. The frozen beet when sliced is of a pure and beautiful white, but with whatever care it be dried, it becomes in the course of the operation perfectly black. This is the effect of fermentation. The effect of carbonization is still more injurious. These evils were the result of inexperience, and have been found completely susceptible of remedy. So far as crystalization took place, (and in many instances it was abundant,) the sugar has proved of excellent quality, free even in its raw state, from any bad taste, and of a pure and sparkling white when refined. Old and extensive dealers have pronounced it in both states capable of successful competition with any sugars in the market. The best result obtained from the beets of 1838, was 7 *lbs. of sugar* from 14 lbs. of dry beet (representing 100 *lbs. of green,)* and 3½ *lbs. of molasses.* In this instance the beets had been dried without much injury except a degree of discoloration. The grain was strong and brilliant but the color deep. It was deemed best to leave a considerable portion of the provision of dried beet of 1838—9 untouched, until an enlargement of the apparatus should enable us to work it up with more ease and economy. The quantity of sugar which we have drained and cured, is 309 lbs. There remains in crystalizers and moulds, not cured, and some of it not sufficiently grained, 1000 lbs. more, and 2000 lbs. of molasses.

Several points of importance were settled to our satisfaction by the labors of 1838—9.

1. That all the saccharine contained in the beet can be extracted by the method of dessication.

2. That the raw sugar can be obtained without any bad taste, and fit for immediate consumption.

3. That American beets, though generally inferior to the European in saccharine richness, can by suitable culture be made inferior to none.

4. That 50 per cent more of crystalizable sugar can be obtained by the method of dessication, than has generally been obtained by grating and pressing, or macerating the green beet.

5. That the beet, once dried, may be kept an indefinite time without liability to injury.

The general result of the first season was, however, unsatisfactory. The quantity of sugar obtained, except on particular days, when the operations were upon select material, was too small; the molasses superabundant, and very bad.

The coming in of the crop of 1839, opened a new era in our enterprise. An improvement in the drying apparatus, by which the access of smoke, and better acquaintance with the management of it, by which fermentation on the one hand and carbonization on the other, were prevented, gave us a nearly unexceptionable material; the liquor was light colored and transparent, the proportion of lime required less, the defecations more prompt and complete, and the concentration almost without scums. The sugar, graining in a few hours, drained well, and is not inferior in flavor or appearance to the finest West India muscovados. The quality of the molasses has been a matter of utter surprise to us. In France the molasses is considered of no value except for feeding animals, or for distilling; and it sells at 4 or 5 cents a gallon. The molasses from the sugar in question, is of a bright amber color, and so pure and pleasant, as to be preferred by many to any but sugar-baker's.

The quantity of saccharine obtained from the beets of this year, has not been so great as from those of the last year. It has in no instance exceeded $8\frac{1}{2}$ per cent, 6 of which was sugar and $2\frac{1}{2}$ molasses. We attribute the difference to the extraordinary wetness of this season.

It will be readily conceived that a small establishment dependent upon farmers for material, paying for it twice the cost of its production, and executing by hand several heavy and tedious operations, which ought to be performed by steam, water or horse-power, cannot furnish accurate data for determining the expense of making beet-sugar. The actual cost, when the material was good, has been 11 *cents* per pound, the pulp and manure not taken into the account. We are of opinion that with proper and sufficient means beet sugar may be manufactured in the United States at 4 *cents* per pound. When the manufacture shall have become domesticated among us, it will probably be produced at a cost less than that.

We have recently made some experiments with the aid of *Mr. Martial Duroy* of Boston, upon beet dried by steam. The result has been a white sugar obtained at once, fully equal to the clayed sugars of Havana.

Other plants usually grown in our soil are capable of furnishing sugar, and some of them may be found worth cultivating for that and accessory products. We have tried Indian cornstalks and the pumpkin, and have obtained from them good sugar and molasses. Perhaps those crops may alternate advantageously with the beet. If the manufacture of sugar from the stalks of Indian corn can be reconciled, as we believe it may, with the maturity or near maturity of the ears, this source of saccharine may supersede the beet-root. The seeds of the pumpkin yield a fine sweet oil, but we have no means of judging, what quantity of this product can be obtained from a given extent of land. If it should turn out satisfactorily in this respect, the pumpkin may one day overshadow the sugar-cane.

It has recently been stated in an agricultural journal * that Schuzenbach's system has been tried in France and failed. We could not credit this announcement, because

* New England Farmer.

we had tried the system, and were perfectly satisfied that it is capable of producing results far superior to those of any other system, which has yet been tested. The following letter from the brother of the inventor, gives timely and satisfactory information on this subject.

Philadelphia, Oct. 29, 1839.

D. Lee Child, Esq.

Dear Sir, — I received some days ago a letter from my brother in Germany, who writes to me the following regular results, such as they are obtained on a large scale in the beet-sugar manufactories in Polen, South Germany, Ratisbon, Wayhäusel, Paris, Toulouse, &c. &c., and as I believe they will be interesting to you, I address you the present for your information.

To produce 100 lbs. of beet sugar of the quality, which is known in France by the name of *bonne quatrième* (good brown) there is required: —

1. 1,250 to 1300 pounds of fresh beets, such as they come from the fields.
2. 350 to 360 pounds of stone coal.
3. 100 pounds of animal charcoal.
4. 1⅔ day's works.
5. Lime, acid, light, &c. &c., for 12½ cents.

To this must be added the interest, the use of the buildings, utensils, &c. &c.

By this method, the cost (prix de revient) of 100 lbs. of this sugar is in Germany, owing to the high price of the raw material, fr. 9½ or 10, or $3,50 to $4; and in the north of France fr. 18,20*c*, or about $3,45, after deducting the price of the molasses.

My brother has made the following important improvements, which have completely succeeded on a small scale for the last five months. They are now brought into operation in two of the most important factories on a large scale, and will, as my brother thinks, succeed there also. By this process a quality is obtained, which will not be inferior to *white* Havana, ⅓ more valued than *bonne quatèrime,* and the expenses will be reduced to the following:—

a. 1250 to 1300 pounds of beets, as above.
b. 250 to 300 pounds of stone coal.
c. 16 to 20 cents animal charcoal.
d. One day's work, (12 hours including meal-time.)
e. Small costs, same as above.

And, what is of the greatest importance, the stock capital, which is required for buidings, utensils, &c. of the factory, will be $\frac{1}{2}$, perhaps $\frac{3}{4}$ smaller, the manufacturing process more simple and of consequence, more certain.

I remain, Dear Sir,
Respectfully yours,
Jos. Schuzenbach.

It appears therefore that Schuzenbach's method as already practised on a large scale in France, turns out good brown sugar at a cost of less than 4 *cents* per pound ; and promises to do still better than this, both as it respects price and quality. Mr. Schuzenbach's last results, as here described, are strikingly like those we obtained in working upon steam-dried beet.

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§ 19.

DIVERS PROCESSES AND MACHINES.

Mr. Dimitri Davidof, a scientific Russian manufacturer, proposes in a work published in 1837, a considerable change in the system of *tubs*, and in the defecation and concentration of juice. He macerates pulp, not slices or ribands. He avoids the inconvenience of extreme slowness, which has been experienced in operating upon material in this form, by introducing so small a quantity into each tub, that the mass of pulp and water can be stirred and well mixed with a small wooden rake. He also avoids the necessity of double bottoms to his tubs by placing a triangular prism of straight straw against the orifice of the discharging cock of each tub, and confining it by a couple of small battens, standing obliquely betwixt the wall and bottom of the tub.

These are movable, and are held in position by two other battens, nailed, one to the bottom and the other to the walls, about 5 inches above the bottom. The two first battens are placed 6 or 8 inches apart.* The bottoms of the tubs are inclined 2 or 3 inches towards the orifice of the discharging cock. They are ranged in series of 8, having a common reservoir of water, which communicates by one gutter or pipe over every two series. The plane of the bottom of each tub commands that of the top of the next one by 5 or 6 inches. The tubs are 3 feet in diameter and 2 feet in depth. The layer of pulp, spread nicely with the rake, is 10 inches thick, and 1 pint of cold water from the reservoir, or water not saturated from a preceding tub, is admitted to every pound of pulp. A cover, pierced with small holes, is fitted to the tub, and rests upon 5 shoulders, attached to the staves at such a height as that the surface of the pulp, when raised by the water, will be a little above them.

The water or weak juice is not permitted to flow upon the pulp in a current, but is splashed upon it by means of a semi-cylinder or trough of tin, containing 8 gallons, which is made to pivot by means of gudgeons fixed to the two heads and bearing on the edges of the tubs. When water has been affused, so that about 44 gallons stand above the pulp, the latter being supposed to be 350 lbs. the semi-cylinder is removed to another tub, and the rake is taken. The pulp is gradually raked up until the bottom is reached ; and then the mass is thoroughly mixed by hauling with the rake from bottom to top. The cover is then forced home to the shoulders and confined there by 5 tourniquets. The crack betwixt the cover and the walls, is caulked, so that no juice may pass there. The water or weak juice is then permitted to run upon the cover until it stands 2 inches above it. In drawing off the liquor the discharge is so regulated as to pass 1 gallon in a minute. It must not much exceed this. Each tub will give 30 or 31 gallons, which must not go to the great reservoir of juice, unless it be as rich into ¼ or ½ a degree, as the juice of the same beet would be, if extracted

* **This improvement was made by Count Bobrinsky, a Russian manufacturer.**

by the press. Until it arrives at this, which is commonly 6° or 7°, it must be passed through the pulp of successive tubs. Each series of tubs has 3 gutters, equal in length to the series itself. One runs from the head to the foot of the series, and receives from any of the tubs its juice raised to the required richness. Another runs in the opposite direction, and conveys to a small reservoir at the head of the series, weak juice from the lowest, which requires to be passed through other pulp. A third carries off the washings and rinsings of the tubs to a drain, or out of doors. Also movable gutters, pipes and snouts are used to pass the water from the gutter of the common reservoir of water, to the tubs, and the weak juice from one tub to another, and the juice from the tubs to the gutter of the general reservoir of juice, placed below and at the end of all the series. Four series of such tubs will wash to the almost entire exhaustion of their saccharine matter, 48,488 lbs. of pulp in 24 hours.*

Mr. Davidof assures us that by this process, by defecating without heat, and concentrating with the inclined plane, he obtains raw sugar *as white as snow*.

His method of defecating is as follows: Having nearly filled a tub, which is 3½ feet deep, with juice, he sprinkles upon it caustic lime, reduced to a fine powder and sifted. No stirring takes place in this operation. The lime by its own weight tends to the bottom, carrying down impurities, combining with the *gluten*, and precipitating it. The sprinkling is renewed every few minutes until the quantity of lime required, is injected. This quantity is 550 grains to 1 gallon of juice. The mass is left to repose, for sometime, after which animal charcoal, in powder, in the proportion of 800 to 1000 grains to 1 gallon, is injected in the same manner as the lime was. In a few hours the juice becomes limpid and of a rose color.

Another method of defecating without heat, successfully applied by Mr. Davidof, is to acidulate the juice at the rate

* Originally Mr. Davidof acidulated the water to be used in leaching the pulp. He added to it 140 to 175 grains of sulphuric acid for every gallon of juice contained in the pulp. The acid was at a density of 67° and diluted with 15 to 20 times its volume of water.

of 175 grains of sulphuric acid to 1 gallon, or 315 grains of sulphate of zinc, or sulphate of alumina to 1 gallon. The deposit is then permitted to form and the clear juice drawn off. Powdered lime, in a caustic state and sifted, is then injected by sprinkling, at the rate of 136 grains to 1 gallon, over and above what is necessary to neutralize the acid.

In the case of juice obtained by washing pulp with acidulated water, the same process is to be observed in regard to lime, except that it is all added at once in form of milk or cream of lime, and the mass is stirred powerfully with a ladle of copper and of a long handle, and the mixture is to be dipped up from the bottom, raised to the greatest convenient height, and projected from it into the tub again. In a little time the deposit of sediment is completed.

Mr. Dombasle, by uncommon science and sagacity, early employed in the service of the beet sugar manufacture, has associated his name with the germ of nearly every important improvement, which has been made since the labors of Achard. By reflecting upon the injurious effects of a protracted exposure of syrup to a high heat, he was led, so far back as 1811, to the contrivance of an apparatus, by which the concentration would be effected with greater promptitude and at a lower temperature, than in any of the ordinary concentrating pans. For this purpose he fixed in a frame of wood a sheet of tin 2 feet long, and 1 foot wide, with longitudinal rims, a few lines in height, but with no rims at the ends. This he established over a small steam generator in such a manner as to give to its length an inclination of 5°. The lower end terminated in a beak, by which all the liquid poured upon the surface might pass off. Over the upper end was placed a small reservoir, communicating with the inclined plane by twelve small funnels, terminated by fine tubes, capable of emitting small threads of liquid upon the superior part of the plane, which expanding by the force of gravity, formed a sheet over its whole surface.

The reservoir being charged with juice, and the water of the generator brought to ebullition, the communication betwixt the reservoir and the inclined plane was opened. At first the juice passed over the plane in ¼ minute, but in proportion as it thickened, it passed slower. The whole time occupied in the concentration, during which six passages were made over the inclined plane, was 3 minutes. Although the heat of the generator was raised to the boiling point, that of the exterior surface of the inclined plane, and consequently that to which the juice was exposed, was much less. It was not so great by 100° as that at which syrups generally boil.

"The color of this syrup," says Mr. Dombasle, "was that of fine honey. It crystalized readily, the molasses came off freely, and the sugar was as white as the finest loaf-sugar before claying. The molasses having been left to itself again furnished an abundance of crystals almost as white as the first; and the second molasses, being again abandoned to itself crystalized to the last drop." It was therefore proved, without Mr. Payen's more recent experiments, that the beet does not naturally contain uncrystalizable sugar, *i. e.* molasses.

After these remarkable results, Mr. Dombasle sought to construct inclined planes on a scale large enough for his factory, but in this he failed. He found it impossible to establish and maintain a large surface of a thin metallic sheet, with such levelness and uniformity that a delicate layer of liquid would pass without interruption and agglomeration in some places, and undue attenuation in others. This was a fatal defect, and Mr. Dombasle was constrained to convert his inclined into level planes, and employ them in the grainage of syrups, a process which he substituted for boiling. This he executed at a heat of 180° to 200°, obtaining thereby a product of superior beauty, and ½ per cent more in quantity, than by the ordinary process.

Mr. Davidof has succeeded in overcoming the obstacles which presented themselves to Mr. Dombasle, by soldering strips of sheet copper edgewise along the entire length of the inclined planes. These strips are ½ an inch high, and ½ an inch apart, forming small compartments or channels over the whole surface of the plane, and imparting to it such firmness that two men may walk upon it without bending or breaking it. To strengthen it transversely small bars of iron are soldered to its under side, also edgewise. The whole plane is 18 to 20 feet long and 3 feet wide. The steam is used at very low pressure, and yet juice received at 2° of density, is brought in 4 minutes to 25°. Upwards of a gallon is concentrated every minute. Thus, one inclined plane concentrates 1500 gallons in 24 hours. Two would be necessary for the concentration to 25° in a pretty large establishment, and a vacuum or other pan for boiling to 40° or 41°, the point of crystalization.

Another defect of Mr. Dombasle's apparatus was, that he had a very small heating surface to his generator, in comparison with the evaporating surface, which he wished to establish. The great advance in the science of steam power since that time enables us to see that the heating and the evaporating surfaces, where the heat is maintained at only 212°, ought to be about equal. An additional advantage of this apparatus is, that any impurities which the juice may still contain, are deposited on the plane during its passage over it. The planes are easily cleaned with a little water and a brush.

The greatest improvement which we are aware of in the system of grating and pressing, has been made by *Mr. Pecqueur*, a machinist of Paris. It adds considerably to the celerity and economy of the operations. It is a grater and press combined. The press consists of two hollow cylinders thickly perforated, and bound with wire gauze. These cylinders revolve without cessation. The pulp falls from the grater into a large funnel or hopper, and through that arrives under the piston of a forcing pump. This drives it continually into a box under the two cylinders, by which it is drawn in between them and pressed. The juice runs through the wire-gauze and the holes of the cylinders, and being thus separated from the pulp, it passes to a reservoir or to the defecating pans. The pulp falls upon the outside upon a floor or pavement, or into baskets, and is found to be in a beautiful state for feed. The pushers being moved by a pulley attached to a double crank, as was the case at Pelves in France, where we saw this machine in operation, the whole attendance required is one man, with a boy to remove the pulp. The distance between the cylinders, and consequently the pression, is increased or diminished at pleasure. We do not think the pression by these cylinders is, or can be made equal to that of the hydrostatic press; but the loss is in a degree compensated by the superior quality of the pulp. Several of Mr. Pecqueur's machines are now in use, and some of the oldest and best manufacturers whom we have conversed with, were thinking of adopting it. The price of this machine is $1330.

Mr. Pelletan of Paris, has invented a machine which he has named the *Levigator*. It unites maceration with a slight pression, or rather trituration. The pulp falls from the grater into a semi-cylindrical trough, 16 feet long by 2½ wide, where it is mixed with about 15 per cent of water. A sort of Archimedes screw, composed of half disks, pierced like a cullender, and fixed on a common arbor, turns and bears the pulp against other half disks, which are immovable, and divide the trough. By the rotary movement the pulp is passed from one pair of half disks, operating together not unlike the upper and nether mill-stones, to another pair, and so on until it has run the gauntlet of the whole length of the trough. One end of the trough is raised 2 feet higher than the other. At this end the pulp arrives in its exhausted state, and is discharged into a lower apartment, or upon an inclined plane, which conveys it out of doors. The water for the maceration falls in at the same end in a measured stream, and the juice passes out quite limpid, and at a density of 6° at the lower end.

In 1836 a manufactory was set up at Seclin, near Lille, on this plan, which in 1837, when we saw it, was working to the satisfaction of the proprietor. In that year a large one was erected in Tuscany on the same plan. Mr. Pelletan affirms that with this apparatus, he makes raw sugar of superior purity and perfectly good flavor, at a cost of 5 cents a pound at most, and generally at 4 cents only; and that the profit on a product of 275,500 lbs., which is ordinarily but $6650 will be increased to $11,875. This he pretends is effected; — 1. By imparting such celerity to the operations as to prevent the slightest fermentation. 2. By extracting from $\frac{1}{6}$ to $\frac{1}{4}$ more sugar; *i. e.* 6 to 7 per cent where the press would give but 5. The price of this apparatus, including a press for the pulp, after it falls from the *levigator*, is $1235.

Mr. Bouchet de Saint Arnoult, a manufacturer near Paris, has invented a machine which he calls *the Saturator*. It exposes the beet cut in slices, to the action of a powerful steam. By this means the vesicles of the beet containing the sugar are ruptured, after which the latter is dissolved in water either cold or hot. The juice thus obtained is very limpid. Mr. Bouchet proposes to perform the defecation cold, and to concentrate with an inclined plane, differing somewhat from that of Dombasle and Davidof. He forms channels both transversely and longitudinally, and uses steam at a high pressure. By this apparatus the juice is brought to 25° in 3 minutes. Mr. Bouchet claims for his system the immense advantage of producing a pure and beautiful sugar at a cost of less than 3 cents a pound.

Finally, *Messrs. Sorel and Gautier* claim to be the authors of a system, from which they promise unrivalled advantages. They grate the beet with a hand grater, deprive the pulp of its saccharine by an instrument they call *the Extractor*, which they declare doth completely exhaust it, and give a purer liquor than either pression or maceration, properly so called. This system, however, is a mode of maceration, and differs from that of Davidof only in the form of the instrument for executing it. A complete apparatus of Sorel and Gautier, capable of working up 600,000 pounds, is stated by the inventors to cost $1254. They state that the current expenses of operating to that extent are $1881, and by the grater and presses, $2337; that the amount of product will be 42,000 pounds instead of 30,000 pounds, as by the common systems; and that the cost of the sugar will be only 2$\frac{1}{3}$ cents per pound.

There is a class of machines of great and increasing importance in the preparation of sugars, both raw and refined, called *vacuum pans.* These pans have been variously modified, and much multiplied of late. The original of them all, was the invention of the *Hon. Edward Charles Howard,* of Westborough Green, near London, for which he obtained a patent on the 20th of November, 1813. It is based on two principles. 1. "That no solution of sugar in water can, unless already highly concentrated, be exposed to its boiling temperature under the common atmospheric pressure during the time requisite for evaporating it, to the crystalizing point, without material injury to its color and crystalizing power." This principle Mr. Howard claims to have discovered. 2. That the boiling temperature in every liquid, may be lowered in proportion as the atmospheric pressure is diminished.

At first Mr. Howard concentrated his liquor at a temperature of about 200°, which he obtained by steam at the pressure of one atmosphere, or by hot water. This was precisely the heat, both in kind and degree, used by Mr. Dombasle in his beautiful experiment of the inclined plane. The first patent obtained by Mr. Howard, which was dated Oct. 31, 1812, specified this mode of concentration, as a part of his discovery of a new "process for preparing and refining sugar." His vacuum pan was an improvement, made by him during that and the subsequent year.

This pan is a hollow spheroid having the poles of the vertical axis depressed, and the lower one more depressed than the upper. It is formed by two hemispheres, of which the lower, (if steam is to be used for the heating,) is double, *i. e.* has an outer pan or jacket to the first, attached by flanges. The whole is put together by bolts and rivets, with packing between the flanges, to keep the joints air tight. The liquor is passed from a reservoir above into the pan by a pipe furnished with a stop-cock. A tube, issuing from the upper hemisphere, called the dome, connects the cavity of the pan with an air-pump, placed in any convenient situation, and driven by steam or any other power. The air being exhausted from the cavity so as to support only an inch of mercury, the liquor is let in, so as to occupy nearly the whole of the lower hemisphere. The steam, at a pressure of three or four pounds to the inch, is admitted into the chamber betwixt the lower hemisphere and its jacket. An outlet is provided for the waste steam and condensed water. The liquor boils rapidly at a temperature of 150°, and the vapor which rises from its surface, is aspired by the air-pump as fast as it is formed. For the purpose of ascertaining from time to time the state of concentration of the syrup, an instrument called a proof-rod, is ingeniously contrived to withdraw a little syrup without admitting any air. The state of concentration of the syrup may also be known by a thermometer, upon the same principle as in the boiling of syrups under the common atmospheric pressure. For this purpose a barometer as well as thermometer, is set in the upper hemisphere of the pan, and the operator notes the temperature at which, under a given pressure, always shown by the barometer, the syrup attains the crystalizing point. The pan is made of stout rolled copper, about 5 feet in diameter, the bottom 16 inches deep and the dome 2 feet high.

Mr. Roth, of Paris has made a vacuum pan, which French authors pretend has nothing in common with Howard's. It consists of a double bottom and dome with liquor pipe, stop-cock and steam-pipe, proof-rod, &c., as already described. But Mr. Roth in addition to the steam in the double bottom, introduces it also into the cavity of the pan by means of a coil of pipe, resting on the interior bottom. Of course a branch steam-pipe with its waste-pipe is requisite for this. He also produces his vacuum by steam, and a second branch pipe is required for this. The steam being injected into the cavity of the pan, drives out the atmospheric air both from this, and from a refrigerating and condensing vessel connected by a pipe with it. In this vessel the steam is immediately condensed by the admission of cold water, which falls in a shower. Thus a vacuum, or rather a low atmospheric pressure is obtained; and it is continued by the vapor, arising from the ebullition of the liquor, constantly passing off and being condensed in the shower bath, as we may call the condensing and refrigerating vessel. The condensed water remains at a tempera ture of 125°, and may be sent back to the steam generator, or passed to a reservoir of hot water, to be used for various purposes, such as washing animal charcoal, bags, towels, hurdles, &c. This pan was contrived after Mr. Howard's was well known in France, and whatever may be its merits, it is impossible for an impartial mind not to perceive that it is a mere modification of the English apparatus. On the subject of originality and priority of discoveries and inventions, nations the most civilized retain a narrowness and jealousy, which savor too much of barbarism.

There is an English apparatus for boiling or evaporating solutions of sugar, patented by *John Davis* of Goodman's Fields, London, March 29, 1828. This embraces the chief distinctive principle of Roth's pan. It expels the atmospheric air from the dome by steam, but is the steam formed from the evaporation of the liquid, subjected to the operation. In the condensing and refrigerating vessel, he establishes a torricellian vacuum, which is afterwards maintained by water falling in a shower among the steam or vapor, as it comes off the liquid. This vapor however is divided into two currents, one of which goes directly to the refrigerating and condensing vessel and the other to a vessel which supplies the water to form the shower. Another distinctive feature of this apparatus is, that the water thus used, is first deprived very nearly of the air, contained therein, by putting in action rotary paddles, and suffering the air, after its expulsion from the water, to escape through a valve above.

Marmaduke Robinson, of Westminster, patented, Aug. 5, 1830, "improvements in making and purifying sugars." The improvement in *boiling*, consisted in employing steam at high pressure in one or more worms or coils of pipe *inside* of a vacuum pan, and not any heat *outside*. The pressure to be used is from 20 to 40 lbs. to the square inch, but he prefers 35 lbs.

John Aitchison, of Glasgow, patented, Sept. 15, 1829, "improvements in the concentrating and evaporating of cane juice, solutions of sugar and other fluids." The great thing in this apparatus is a double cylinder, turning within a close pan, and about $\frac{3}{8}$ of it within the liquid to be evaporated. The ends of the cylinder are open. Steam is passed into the chamber of the double cylinder, through a gudgeon and one of the radial arms, and the waste steam passes off through a like arm and the gudgeon at the opposite end; and thence into the chamber of the double bottom of the pan itself, which having heated, it goes off as condensed water through a cock inserted in the outer bottom of the pan. This pan is oblong and semi-cylindrical in form, and has a roof or casing of wood established atop, which excludes the atmospheric air. In the upper part of the roof at the end is an apperture communicating with a ventilating box, in which a revolving fan is mounted upon a horizontal axle. The workman, or any moving force, which turns the double cylinder, gives a rapid motion to the fan, which expels the air from the box, and aspires it, and also the vapor, as it rises from the pan. Thus a partial vacuum is produced. The juice, syrup or other liquid, attaches itself to the revolving cylinder in a thin coat both inside and out. In that situation the concentration is very rapid, upon the same principle as Mr. Dombasle's thin sheet of liquor upon the inclined plane. Three scrapers are so disposed as to scrape the syrup as it thickens from the bottom of the pan, and from both surfaces of the cylinder.

A patent of importation for this apparatus was taken out in France by *Miles Berry* in 1830.

Mr. Champannois, one of the inventors of the macerator, has contrived an apparatus for the concentration of juice and syrups, which is another form of Mr. Dombasle's principle. He causes the liquid to be distilled upon the top of a column or columns 15 feet high, and 3 feet in diameter, composed of rolled copper 1 line in thickness, and heated by steam at a low pressure. The liquor flows down the columns in a uniform coat. Each particle of liquid in order to concentrate it to 28° or 30° is exposed to a boiling heat only 2 or 3 minutes.

There is an apparatus in France called ***Degrand's***, which consists of Roth's vacuum pan and an ingenious appendage, by which the steam, coming from the syrup undergoing evaporation in the pan, is used for concentrating fresh juice to the consistence of syrup. Of course this concentration is effected *without fuel.* Two series of copper tubes 3 or 4 inches in diameter, 8 or 10 feet long and 20 or 30 in each series, are arranged like the lengths of an American rail-fence, only the posts must be supposed to be vertical tubes, which form communications between all the horizontal tubes of a series. The steam or vapor from the pan comes into these, (in which a vacuum has been previously created at the same time that it was done in the pan itself,) and it heats them to the boiling temperature, while it does itself become condensed, and thus maintains the vacuum. The juice is made to fall from wide funnels, having many small tubes upon the top tubes of the two series. These are immediately covered with thin coats of the liquid, which trickles from one to another, and thus the series are covered and kept so as long as the operator chooses. From the last tubes in the series the juice, now highly concentrated, passes to a reservoir under the vacuum pan, into which by merely turning a cock, it is cast at pleasure. The condensed water passes from the series of tubes into a cylinder, from which it can at any time be expelled, and a vacuum created in lieu of it, without interrupting the operations. This vacuum being at the end of the condensing tubes, and thus in communication with the vacuum pan, serves to refresh from time to time the vacuum in all these, and thus to accelerate and perfect the work. These two series of tubes are called the *condenser.* It is the invention of *Charles Derosne* of Paris.

Two apparatuses have been invented and patented in England as improvements in evaporating and boiling syrups and other saline liquors, by the injection of *hot air;* the first by *William Godfrey Kneller*, of London, Nov. 27, 1828; and the second by *William Newton* of London, Jan. 20, 1833. The air being heated and propelled by a pneumatic apparatus, is infused among the liquid, agitating it and renewing its surface, while it dilates and takes off the water by its heat.

An apparatus upon the same principle has been patented in France by *Brame Chevalier*, of Lille. This species of machine has not found much favor, though it is considered by some well adapted to the refining of sugar.

It is to be observed of concentrating pans of every sort, that deposits of carbonate and sulphate of lime are formed upon their bottoms, and upon the worms or coils of pipe resting thereon. They thus become coated with a hard incrustation, which obstructs the transmission of heat. They must therefore be cleaned as often as once a week. For this purpose water is thrown into them, and a small quantity of muriatic or sulphuric acid added thereto. They are then scoured with a rag, brush, or broom.

The advantages of the vacuum pan are, that syrups or molasses, which are too poor to furnish sugar, when concentrated under the common atmospheric pressure, will yield it when concentrated in this; that the vapor of which more or less usually expands in the workshop, and soils and deteriorates the utensils and buildings, is used up or carried off; that the sugar is whiter, and more abundant, and the proportion of molasses less. The expense of such pans is considerable. They are used almost universally in the refining of sugars, and to a small, but increasing extent, in the manufacture of them.

The vacuum pans have been adopted with extraordinary advantages in the manufacture of cane-sugar on some of the English plantations. It is represented by *Messrs. Oaks & Dobson*, manufacturers of the apparatus, and that by means of it "*canes, growing in the field in the morning, are converted into a beautiful white sugar in the evening.*" While we are far from asserting that such result is impossible, we may assert, that we are in possession of a sample of the Demarara vacuum boiled sugar, and that it is far from being white. The grain or crystal is very strong and brilliant, and purer than the finest muscovados.

In making this sugar, the evaporation is effected in the old pans, and the juice cleaned and skimmed in the ordinary way. When it has acquired the density of equal parts of water and saccharine, it is conveyed into receivers, and thence to the vacuum pans. Here it is kept at a temperature of 145° to 150°, until it is granulated.

The sugar is then discharged into a circular receiver, surrounded by a steam case, and there retained until the temperature is raised to 185°. It is thence removed into the curing boxes. These boxes are rectangular, with false bottoms of perforated metal, a few inches above the outer bottoms.

Upon the false bottoms the sugar is spread in smooth layers of 6 or 7 inches; and valves connecting the cavities betwixt the two bottoms, with an air-pump, are opened. The air of these cavities is quickly exhausted, and the superincumbent atmosphere presses through the sugar with such force as to drive before it the molasses, and with two or three repetitions, completely expel it.

The advantages of these processes, and this apparatus are: —

1. That in two hours the sugar made during a day, say 5,000 lbs., can be perfectly cured, and made ready for the market, without the expense of curing room or hot-house.

2. That the molasses is all saved, none being left in the sugar to run out, or to ferment during transportation and storage.

3. That the quantity of sugar is greater; 42,000 lbs. having been made from 37,300 gallons of cane juice, while *in the same week* only 36,800 lbs. of sugar were made from 38,500 gallons of juice in the ordinary way; the new method thus giving in one week 5000 lbs. more product from 1200 gallons less material.

4. That the quality of the sugar is so much better as to command 12 per cent more money in the market.

This apparatus has been employed for many years in the refineries, both of England and the United States. Without having witnessed its operation in the manufacture of sugar, we are impressed with the belief that it would be precisely the thing for extensive sugar-beet works.

§ 20.

THE SMALL AND HOUSEHOLD MANUFACTURE OF BEET-SUGAR.

Too much has been said of the manufacture of beet-sugar in a small way, to permit us to pass this topic in silence. There can be no doubt of the practicability of making beet sugar on any required scale from 1 lb. to 10,000 lbs. per day, but it cannot be made on any scale with profit without considerable skill and experience. Also, the larger the scale, provided it do not exceed the limits of good management, the greater will be the profit. But this constitutes no objection to the household or domestic manufacture of beet sugar; because it is well known that many manufactures may be carried on in families by the aid of women and children, and in the idle season of the year, to the great advantage of individuals and the country, though the same would be ruinous to the regular manufacturer. The most of our New England farming, if considered as an object of capitalists, and hired labor, instead of being executed by the yeomanry and their sons and daughters, would be intolerable.

On the other hand, owing to want of skill or of suitable apparatus, no farmer or other person in Europe has given us a satisfactory example of the production of beet sugar, as a household manufacture, suited to become auxiliary to agriculture, however limited. Yet this is a cherished aim of the writers, and of the public sentiment of France.

There is no efficient apparatus, which is simple and cheap enough to suit the purpose of common farmers. Yet we believe that the time will come when sugar-mills will be set up by the more forehanded of our farmers, as cider-mills now are; and that sugar-beets, which may be produced by those who cannot afford to build a mill, will be carried to their neighbor's, and worked up on shares, or at a certain rate in money on the amount of material or of product, as cider is made among us, and as wine is made in the French communes. In the East, there are itinerant sugar-makers, who are provided with a movable apparatus, which they establish under a bamboo shed in a given neighborhood, and work up the canes, as the cultivaters bring them in. Mr. Nosarewski suggests this as a practicable mode of domesticating the beet sugar manufacture in Poland, in connexion with his system of drying the beet.

The question of the small and household manufacture of beet sugar, is one which we are not prepared to resolve. The country must first acquire confidence and some skill in the business. Above all it must be disabused of the notion that the business can be conducted without any skill. By the time that these preliminary objects are attained, experience will suggest the ways and means of effectuating the wishes of the people. We have no hesitation in adding that, if we had the management of a farm and the rearing and fattening of stock, we would try a small beet sugar-mill, even if all the improvements announced or projected should prove to be moonshine. The advantages which such an appendage is capable of yielding on either of the old French plans, imperfect as these confessedly are, would be a precious boon to American farmers.

To one of these who has turned his thoughts to this subject the question will occur.—'How would you go to work in such a case?'

We should adopt the grater and presses, mainly because the pulp coming from these is better for feed. This opinion does not militate with that which we have expressed in favor of the macerator, for that was in reference to large works, capable of making at least 1500 lbs. of sugar per day. But even in this case we should in some localities prefer the grater and presses.

We should make our own grater with a little assistance from a carpenter or millwright. The expense in money, including sawplates, arbor and pulleys, would be about $10. We should also construct with so much assistance as might be necessary, a power for a horse or ox, which should give the movement to the grater and presses. This we estimate at $40, including communicating machinery.

For presses we should take two old screws, either of wood or iron, as we could light upon them, and construct frames, followers, &c. with some assistance as before. These, at $20 apiece, would be $40. For sacks we should use coarse unbleached cotton, burlap, or old coffee bags. We should thus obtain 75 of these, and a dozen more of twilled cotton or of duck for scums and sediment, for about $12. For hurdles we should purchase champaign baskets, and take the lids, reserving the other part for draining the sugar, made by reboiling molasses, and for other uses in and about the workshop, $15.

2 defecating pans of 30 gallons each, $24. 2 concentrating pans of 75 gallons each, $50. 1 boiler of 50 gallons, $20. 1 cooler, $15. Brick, mason's work and grates for furnaces, $50.

We should purchase quarter wine casks, and cut off one end, leaving on the other part all the bulge hoops. The ends thus cut off being furnished with a top hoop thick enough to lay hold and lift by, make excellent vessels for receiving and transvasing juice and syrup. The large parts are good filtering boxes, 6 of which with towels and strainers to correspond, would cost $12, including the tubs.

A small kiln and 20 crucibles for manufacturing and revivifying animal black, would cost $75; and 30 crystalizers on the plan of Payen, $15. Ladle, skimmer and basin, $5.

Recapitulation.

Grater	$10 00
Horsepower	40 00
2 presses	40 00
87 sacks	12 00
80 hurdles	15 00
2 defecating pans . .	24 00
2 concentrating pans . .	50 00
Boiler	20 00
5 furnaces	50 00
Cooler	15 00
Filtering boxes . . .	12 00
Kiln and crucibles . .	75 00
Crystalizers	15 00
Basin, skimmer and ladle .	5 00
Contingent expenses . .	20 00
Total . .	$403 00

With this apparatus, 2 men and 2 boys, or a man, woman and 2 boys or girls, would work up 1 ton of beets, and make 100 lbs. of sugar in a day. The pulp would feed 4 oxen, 6 cows and 30 sheep. During three months beginning the middle of October and ending the middle of January, they could work up the produce of 5 acres, and make 7800 lbs. of raw sugar. This at 6 cents a pound would be

	$468 00
Pulp and molasses, used on the premises for feeding and fattening cattle and sheep	160 00
Total income, exclusive of manure .	$628 00

Expenses.

Rent, interest and wear of apparatus .	$70 00
Beets	156 00
Labor	170 00
Fuel and light	100 00
Bones	30 00
Chemicals	5 00
Total	$521 00
Net profit	$107 00

Thus a farmer, after deducting his own board and wages, and those of any member of his family, or other person employed in the work, and paying the interest of the investment, and all other expenses, would have above 100 dollars, clear gain, besides the important advantage of preparing his land by the beet culture for superior crops of grain ; and doubling his stable manure, if he chose to increase his live stock, to fat some of it, and consume all his winter feed on the place. If he continued the manufacture until the 1st of March, as it would be worth while to do, for the sake of the pulp, though the sugar would be one or two per cent. less, the profit would be considerably increased.

PART III.

HISTORY AND PROSPECTS OF THE BUSINESS.

It is rather more than a century since *Margraff*, a celebrated Prussian chemist, residing at Berlin, made the discovery that the beet contains a good crystalizable sugar. His attention was first attracted to the subject by the saccharine savor of the beet, and the crystaline appearance of its flesh, when examined with a microscope. Having cut some beets into thin slices, he dried perfectly and then pulverized them. To *eight* ounces of the powder, he added *sixteen* of highly rectified spirits, and exposed the whole to a gentle heat in a sand bath. As soon as this mash was heated to the boiling point, he removed it from the fire, and filtered it into a flask, which he corked up and left to itself. In a few weeks he found that cystals were formed, which exhibited all the physical and chemical properties of cane sugar. Having submitted several other vegetable substances to the same treatment, he found that they all yielded sugar in different proportions, but none of them so much as the beet. In 1747 he addressed to the Academy of Berlin a memoir, entitled, *Chemical Experiments, made with the view of extracting Genuine Sugar from Divers Plants, which grow in our Countries*. Margraff solved the important problem that genuine sugar is not confined to the cane and the tropics. After this he enlarged and varied his experiments, but did not invent means of making sugar from the new material on a manufacturing scale. Yet he seems to have had a prescience, that his discovery would one day assume importance; and he recommended it to the attention of the Prussian cultivators, and particularly to the small farmers, as offering a new and beneficial branch of agriculture.

It was *Achard*, also a chemist of Berlin, who invented the first method of making beet sugar on a large scale, and at a moderate expense. He first announced this result in 1797. In 1799, a letter from him was inserted in a French periodical, entitled, *The Annals of Chemistry*, in which he gave the details of his method. He there stated the cost at 4¾ *cents* the pound of Silesia, about 6 *cents* the pound avoirdupois, without counting the benefit to be derived from several residuums. He also expressed the opinion that with these included, and with some improvements in the processes, this sugar might be made *at half that cost*.

This announcement caused considerable sensation in the Parisian world, eliciting admiration and ridicule by turns. The high price to which sugar had risen in France, in consequence of the capture by the English of nearly all her colonial possessions, gave something more than a *speculative* interest to the statements of Achard. The National Institute appointed a commission to examine the subject. The result of their investigation was, that the cost of the raw sugar of the beet would be 16 *cents* a pound. The price of sugar was such that even at that cost, a very large profit might have been made; but this consideration was not sufficient to induce many persons to take the risk of a peace with England, supposed at that time to be approaching. Only two establishments were formed, one at St. Ouen and the other at Chelles, in the environs of Paris. Both were failures, partly from the bad quality of their beets, and partly from the inexperience of their conductors. With them went down the hopes which had arisen of this new and interesting branch of industry in France.

It is difficult to say whether these hopes would ever have been resuscitated, if political events of an overruling nature, had not supervened. By the Berlin and Milan decrees all colonial articles were prohibited, and that "continental system," so unjust and extravagant in its design, but so important and premanent in its effects, was introduced. From that time, 1806, chemists and economists applied themselves with renewed zeal to the search after an indigenous source for the supply of an article, once a luxury, but now a necessary of life. It was supposed at one time that this desideratum had been attained in the production of grape syrup and sugar, of which, in the course of two years many millions of pounds were made. This sugar, though abundant in some varieties of the grape, raised in a southern latitude, possesses only $\frac{2}{5}$ of the sweetening power of the sugar of canes and beets. Nevertheless, sugar being at about one dollar a pound, a great number of manufactories were erected, and science and industry were tasked to improve the processes, and bring the product to perfect sugar.

In this state of things it was announced that the beet sugar manufacture had all along been successfully carried on in Silesia. It was declared that from 4 to 6 per cent of sugar was obtained, besides several other valuable matters. Other German chemists had instituted experiments, and published results agreeing with those of Achard. And, now, 1809–10, experiments were recommenced in France, particularly by *Mr. Deyeux*, of the Institute, who had reported on the subject to that body in 1800. These experiments resulted in the production of abundant samples of beet sugar, both clayed and refined, which served to revive and increase the hopes of France in this source of supply. No more than 1 to 2 per cent was obtained; the beets being of an inferior sort, and raised in the neighborhood of Paris, where a vast deal of ammoniacal manure, hostile to the producton of saccharine, is used.

In 1811, *Mr. Drapiez*, of Lille, worked 55 tons of beets, from which he obtained $2\frac{1}{2}$ per cent of brown, and $1\frac{1}{3}$ per cent of refined sugar. In the winter of the same years an experimenter at Paris succeeded in obtaining $4\frac{1}{2}$ per cent from *white* beets, *raised at a considerable distance from Paris, and without manure*. This was the first essay in France which approximated to the results of Achard.

It was made by *Mr. Charles Derosne*, and was detailed in the *Moniteur*. It demonstrated how faulty had been the selection of sorts, and the mode of culture. At this time Achard had published in German an extensive and valuable work in two volumes, in which he had treated with minuteness of every department of the business, from the raising of the seed to the refining of the sugar. This treatise contained not only Achard's experience of thirteen years, but also accounts of the manufacture of beet sugar on a grand scale by other persons in Prussia.

In a report upon these enterprises by a commission, appointed by the Prussian government, the product in sugar was stated at 6 lbs. 1¼ oz. per hundred pounds of beets, and the cost of it at 6 cents and 6 mills per pound.

On the 15th of January, 1812, Napoleon issued a decree, establishing five chemical schools for teaching the processes of beet sugar making, detailing one hundred students from the schools of medicine, pharmacy and chemistry to be instructed in those establishments, and creating four imperial factories, capable of making 4,400,000 lbs. of beet sugar per annum. Munificent premiums were also decreed to several individuals, who had distinguished themselves by their persevering and successful application to this new industry. Among them was *Mr. Isnard*, now resident, as French Vice Consul at Boston. A number of factories were immediately added to those already existing in France, and in 1812–13, a large quantity of beet sugar, both raw and refined, was produced. Mr. Dombasle substituted the colonial method of clarifying the fresh juice, appropriately called *defecation*, for that of Achard, which consisted in the use of sulphuric acid, instead of lime. The colonial method, with few exceptions and some small modifications, now prevails in the manufactories of Europe.

Such was the prosperous beginning in France, when the disasters of Moscow introduced that bane of manufacturing enterprise, an uncertain political future. Confidence and energy gradually gave way to depression and despair. A faint struggle was maintained for one season, until the Cossacks, quartered in the sugar-mills, and the allied artillery seizing upon the beasts that moved them, gave the manufacturers the *coup de grace.* The foreign officers billeted in their houses, became, from curiosity, their principal customers, being struck with the brilliance and purity of this unexpected product. After the final overthrow of Napoleon at Waterloo, the price of refined sugar, which forms the chief consumption of France, fell to 12 cents a pound. Still, to the surprise of all, two beet sugar manufactories survived the shock of this reverse, tremendous indeed but useful, because it demonstrated, what never could have been done under the unnatural stimulus of the "continental system," that the beet sugar business possessed an intrinsic value, rendering it capable of an independent existence, and raising it beyond the reach of accident, political disfavor or caprice. The establishments which survived are at *Arras* in the department of the Pas de Calais, and at *Pont à Mousson,* near Nanci in the department of the Meurthe.

The retirement of the allied armies left French alacrity and energy once more in freedom. Several eminent and patriotic citizens formed beet sugar establishments, more perhaps to give the benefit of experience to their countrymen, than with any view to profit. Men of genius and profound research occupied themselves with experiments and published their results. Among the most important of the early establishments were those of Count Chaptal, Mr. Dombasle, Marshal Marmont, and Mr. Crespel Delisse. Chaptal in his *Memoirs on Beet Sugar,* related the experience of several years in the cultivation of the beet and its conversion into sugar. Mr. Dombasle did the same in his work entitled *Facts and Observations relating to the Manufacture of Beet Sugar,* and in other publications, which have from time to time followed it. This gentleman, with a prospect of many more years of eminent usefulness, still presides over the national farm school at Roville, near Lunéville, in Lorraine. As a skilful and industrious operative, Mr. Crespel deserves honorable mention. He was originally a laborer, and became the foreman of the first beet sugar factory established at Arras. The proprietor having sunk in the general wreck of 1814, Mr. Crespel succeeded him with the advantage of having his fixtures at a reduced price. This was one of the two establishments which survived, and it continues to be one of the most successful in France. Mr. Crespel is interested, either as part or sole proprietor, in seven or eight other farms and factories. He has received a gold medal from the Society of Encouragement at Paris, and the honor of knighthood from the French king and from several foreign sovereigns.

The government have from time to time increased duties on foreign, and on their own colonial sugars, but this has been done with no design to protect the beet sugar manufacturers, but simply for revenue. The competition of beet sugar with colonial has reduced the price of sugar in the markets of France, 50 per cent. Consumption has increased in a ratio almost precisely equal. It is somewhat greater, which may be accounted for from the increase of population. In 1825, the consumption in France was 143,692,021 lbs. In 1836, it was 230,304,549 lbs., being an increase in eleven years of 86,614,528 lbs. During the same period the production of beet sugar increased from 8,816,000 lbs., to 107,905,785 lbs., or 99,089,785 lbs. The excess of this above the increase of consumption is 12,475,257, and to this extent the importation of sugar for consumption fell off. In consequence of the decrease of the revenue derived from the duties on the importation of sugar, which had taken place to the extent of $1,500,000, the government some years ago proposed an excise on beet sugar. In 1837, the legislature very unexpectedly sanctioned this project and it is now a law. This excise is $2,85 on every 220 lbs., to which is to be added a tax of $10 on every license for the manufacture, and the expenses of collection; all which comes to 1 cent and 7 mills per pound. Recently the duties on sugars imported from the French colonies have been reduced, so that the protection of the beet sugar in France, which used to be about 4¼ cents, is now inconsiderable. It is probable that many factories will fail in consequence of these measures; and this we should not upon the whole consider an evil; for in consequence of the great profits, which under good management, have been derived from this business, the rush of competitors has been prodigious. The withdrawal of those, who have trusted to the goodness of the business, rather than to solid capital and competent skill, will be a blessing to the manufacturer, who is possessed of those requisites, and no loss to the country at large. We have no doubt whatever, that the business is destined to continue, and to flourish in France and throughout the continent of Europe. It is the opinion of the oldest and intelligent manufacturers, that in twenty years continental Europe will cease to take sugar from the West Indies. According to late commercial intelligence the demand for West India sugars is rapidly declining in Russia by reason of the increased supply of the indigenous article. The number of beet sugar factories in that country in 1836, was 30, but is doubtless much greater now. At that time the number in Belgium was 20 and increasing. In France in 1837 there were 542 in operation, and 39 in construction. It has recently been stated in the public journals that the states composing the German Customs Union, possessed, in 1838, 87 factories in operation, and 66 in construction. The production of the beet sugar factories averages about 200,000 lbs. each, so that we may reckon for the 203 factories known to exist in other parts of the continent besides France, 40,600,000 lbs. of sugar, making the total annual production of beet sugar in Europe about 150,000,000 lbs. It remains to be observed that in Austria and Italy the business has been commenced with great zeal. It was stated to us by *Mr. Blanquet*, a distinguished manufacturer at Famars, near Valenciennes, that a single Austrian prince was establishing works capable of converting into sugar the produce of 8,000 hectares,—19,750 acres!

In Great Britain and Ireland only two beet sugar factories have been commenced, one of them near London, and the other near Belfast. The first manufactured in 1837 a considerable quantity of refined sugar, which was so completely undistinguishable from refined cane sugar, that the government issued an extraordinary notice to the effect that any attempt fraudulently to export beet sugar with benefit of drawback, would be visited with the severest penalties of the law. It may here be observed that in France a similar fraud is constantly taking place, beet sugar being exported, with benefit of drawback as cane sugar; and that, during the "continental system," cane sugar was smuggled into France and other parts of the continent and sold for beet, the identity of the articles being so perfect as to defy the scrutiny of custom-house officers, and the analysis of chemists to detect any difference.

The factory near London is said to have stopped in consequence of a notice from the government of their intention to lay an excise of about 5 cents a pound upon beet sugar, equal to the duty on East and West India sugars. It is the opinion of Englishmen, skilled in the manufacture and refining of sugar, that the beet sugar business cannot be sustained under such an excise. Others, however, express great confidence that, by means of the application of the dry pulp to paper making, whereby its value is increased fourfold, the business will yet obtain a permanent footing in Great Britain. We do not think that a fair experiment has yet been made in that country. The original prejudice of the English against the new manufacture, forced forward by the odious machinery of the "continental system," to become a rival of their principal colonial staple, was very violent. That it still exists, and that too in minds which ought to be employed in destroying instead of strengthening it, is too apparent from some limited and dogmatical views on the French beet sugar manufacture, in the *Edinburgh Review* of April, 1837. As this article has been much read in the United States, it is proper that we should take some notice of it.

That the protection of the beet sugar manufacture has been very high in France, much higher than the tax on any article of general and necessary use ought ever to be; and that it is still so in most of the continental countries of Europe, we readily admit. It is about 100 per cent on the original cost. We have however seen that the beet sugar business did not perish by the shock of falling from a protection of 300 per cent to almost none at all. For after the general peace, sugar fell as low in France as it is in the free ports of Europe at this time. Refined sugar is stated to have been but 12 cents. An immense stock had accumulated in the sugar colonies, which had been successively captured, and were in the hands of the British, insomuch that they fed horses and other animals on sugar. Yet the working classes of England, under the onerous duty of 6 cents a pound, were drinking their coffee without sugar, and they continue to a great extent to do so to this day. The object of this sacrifice is to protect the West India monopoly. Here is injustice and extravagance of protection to a particular interest at the expense of a whole country, which has no parallel except in the odious "continental system" itself. The protection of beet sugar in France, moderate and wholly incidental, cannot be compared to it. Who does not see that the protection of West India sugar in Great Britain by a prohibition of all other, except from a limited territory in the East, furnishes the same sort of argument in kind, and stronger in degree against the profitableness, and practicability of the production of cane sugar in Jamaica, which is urged by the editors of that celebrated journal against the beet sugar in France. The condemnation of beet sugar in the eyes of the Scottish economists is, that it has received protection. Tried by the same rule, what must be the fate of British West India sugar, and of every important branch of British industry; and of the Louisiana sugar planters, the eastern cotton and woolen manufacturers, salt makers, hat makers, tailors and shoemakers?

The editors state that "the great *impetus* given to beet sugar making in France was in 1806." Now in fact the beet sugar manufacture did not *exist* in France at that time, nor until four years after, nor to an extent worth naming until five or six years after. No "impetus" was given to it until the experiments of 1811, and the decrees of the emperor awarding premiums, and establishing schools and model factories in 1812.

Again, they assert that "in two or three years more France will be fleeced of £2,600,000 per annum for the benefit of the land-owners of *Alsace*." Alsace is not a seat of this manufacture. Comprising two departments it has but 5 beet sugar factories, while the single department of the North has 226, and that of the Pas-de-Calais 138 ! They state the quantity of beet sugar made in France in 1829 at four millions of kilogrammes. It was just double that amount. Such errors show that the editors had not examined the history and present state of the beet sugar business in France, and were not therefore competent to pronounce an opinion upon it.

Their first error lies in not taking into view the fact, (with which they were probably unacquainted,) that it has already been submitted to and has survived that test of its utility which they themselves propose, and before which they assert that "it would quickly disappear," viz., a fair competition with colonial sugars.

The second error consists in assuming that all the revenue which a government fails to derive from duties on importations, in consequence of home supply, is so much wealth lost to the nation. It would follow then that a nation which produces everything within itself, must soon sink under the burden of being exempt from Custom House duties, acknowledged on all hands to be the most cheating and wasteful mode of taxation ! At this rate what immense wealth Great Britain and the United States are respectively losing by their woolen and cotton manufactures, though they are supplied with cheaper and better goods of these kinds than any countries in the world. The assumption is absurd. To have given a semblance of solidity to the argument, it should have been shown that, while the revenue of France from the sugar duties had fallen off, no reduction of price, and no increase of consumption had taken place. The editors seem to have been conscious of this, for they say hesitatingly, that "the actual consumption of sugar in France for the last seven years, is not *supposed* to have materially increased." But it *had* increased in that period more than *fifty per cent*, and the price had fallen *five cents a pound*, or fifty per cent.

It does not appear that the editors had examined any of the French works on this subject, except a couple of pamphlets by a merchant of Havre, who was probably interested in the colonial sugar trade, which, when beet sugar arose, was enjoying an undisputed monopoly of the kingdom. Beet sugar has reduced the price more than fifty per cent, and has increased the consumption in the same proportion. The first of these facts is not noticed by the editors, and the second is denied! Neither is any notice taken of the great fact in the case, that the beet culture and beet sugar manufacture increase manure and fertilize farms in a manner unparalleled by any art, contrivance or discovery in the whole history of agriculture. Listen to Mr. Crespel, who, after 25 years of experience, testifies in 1837, before a committee of the Chamber of Deputies, as follows. "The culture of the beet has increased remarkably the value of real estate. He lately purchased at the rate of $152 per acre some lands which were let at $3,80 an acre. Since he had cultivated these lands with beets in a rotation of crops, the number of sheep kept thereon had doubled, and the neat stock had trebled. The rents of leasehold property had doubled where the land was of middling quality, and in some cases they had quadrupled."

Mr. Spineux, another cultivator and manufacturer in the department of the Somme, testified on the same occasion, "that when he took possession of his farm of 350 acres, it gave a profit of $855. On annexing a beet sugar manufactory he obtained a net profit of $1425."

Mr. Clinchain, of the department of the Sarthe, testified before the same committee, that "he cultivated about 1100 acres, 550 with beets. He procured 100 bullocks from Poitou, which he fed with the pulp and a little straw. His neighbors digged, cleaned and carted his beets for the tops. This practice has the effect of diffusing so much plenty, that during the beet harvest butter falls at Angier, four miles from his factory."

Mr. Ducroquet of the department of Pas-de-Calais, testified, "that having expended $5000 in the culture and manufacture, he received $9000 for his products; that he has quadrupled the number of his sheep, having raised it from 100 badly kept to 400, which he fatted for the butcher.

Independent of the resource which the beet furnishes for the nourishment of animals, *it has the advantage of being the only thing capable of bringing about the suppression of naked fallows.*"

It is the unanimous opinion in the neighborhoods of Dunkirk, Valenciennes and Arras, that real estate has risen at least 50 per cent in consequence of the introduction of the beet sugar. This is the same as if money should spontaneously increase in quantity, so as after a short period to give the lender $150 for 100, besides paying him his interest.

It has been said that the opening of the Erie canal in New York raised the value of real estate in the western and central parts of New York 50 to 100 per cent. The beet sugar culture is better, because it is at the option of every cultivator and manufacturer of enterprise and industry whether he will have it or not. It is what the canal would be if every farmer could bring it by his own door.

Another important effect of the beet sugar culture, is the cleaning and dividing of the soil, serving in this respect as a substitute for fallowing. It is the best of preparations for wheat and other grain crops. In a country like France, where one fourth of the arable land used to lie fallow all the time, the utility of this culture as a substitute for fallowing, is a matter of no slight importance.

To consider then the beet sugar business merely in its manufacturing aspect, leaving out all these rich results, or to urge as an argument against it some little derangement of commerce and revenue, a necessary consequence of any considerable change, be it beneficial or otherwise, is to entertain a narrow and deceptive view of the subject. We readily concede that, considered as a manufacturing business, without giving any additional agricultural profits, or connecting itself with any agricultural improvements, it is not yet proved that it would be very profitable, but that it is highly so when the manufacture is made subsidiary to agriculture, and fills up the inactive season of the northern winter, we confidently believe, and do not expect any intelligent person to deny.

Suppose however, that it should be found that the pulp is worth for paper-making five times its value as feed for animals; or that the processes and machinery of the manufacture should be so perfected that the ten or ten and a half per cent of saccharine known to exist in the beet, should be all extracted and crystalized; in either of these cases beet sugar making would be highly profitable as a mere manufacturing concern. Now, in fact, neither of these improvements is any longer hypothetical. In England Mr. Kyan has obtained a patent for making paper of beet-roots after the juice is expressed. We have seen various specimens of pasteboard, and of firm and durable wrapping paper, made of this new material. We are informed that good printing paper has been made chiefly of the same material; and it is confidently expected that fine writing paper will be produced. The immense and increasing demand for paper, and the vast commerce now carried on in rags, are sufficient proof of the importance of this application of the beet-root pulp.

It is well known to those who have attended to the progress of this business in France, that the profits of the manufacturers have been much absorbed by efforts, probably too earnest, to keep up with the improvements of machinery. Much has been lost in unproductive experiments. It would be ungracious and ungrateful in us to find fault with our French friends on this account; since they have carried the business through the necessary period of infancy, and reared it at their exclusive cost to be a blessing to mankind. They have all along been conscious that they were obtaining from the beet but little more than half its saccharine. This conviction has naturally caused a restlessness, and a constant striving after something more perfect. It is certain that those who have resisted all innovation, and adhered substantially to the original processes and machinery, have been the most successful; but if all had been equally cautious, little improvement would have been made, and mankind would have been at a remoter period, and in a less degree benefited. Nevertheless, we fully believe that the cotton manufacture has never been established in any country with fewer failures, and less fluctuation and loss, than the beet sugar business, all new as it is, in France. We trust that enough has been said in the second part of this treatise, to show that the desideratum which the French manufacturers have so keenly felt, is in all probability attained ; that a method has been discovered by which the beet is deprived of all its saccharine, be the same more or less ; and that it is obtained and operated upon in such a manner as to be nearly all crystalizable. Hitherto a large portion of the saccharine matter extracted from the beet has resulted in molasses, a residuum in the ordinary French systems of manufacture, of very slight value in the market. Of course, every thing which arrests the formation of it, adds by so much to the deposit of sugar, and the profits of the proprietor.

The following are the particulars of the discovery and progress of Mr. Schuzenbach's improvement. Having obtained his result after much study, and many experiments in the laboratory, he communicated it to some distinguished capitalists of Baden, among whom were the wealthy house of de Haber, intimately connected with Rothchilds. Thereupon a company was formed, not however with the immediate design of erecting a factory upon the new system, but merely of proving its pretensions. To this end they advanced 10 per cent on a capital of a million of florins, (about $400,000,) for setting up experimental works, upon a scale so large as to test completely the susceptibility of the method to become *manufacturing*. They, however, took a bond of Mr. Schuzenbach, with securities to refund this advance in case the experiment failed. They appointed a scientific and practical commission to follow closely the experiments of Mr. Schuzenbach, and to report the result. Commissioners from the governments of Wurtemburg and Bavaria also attended. The experiments were continued during five or six weeks, in which seven thousand pounds of sugar of superior grain and purity were produced.

The Baden company were so well satisfied with the report of their commission, that they immediately determined to erect an immense establishment in the environs of Carlsruhe, at an expense of $200,000 for fixtures only, the residue of their capital stock being reserved for current expenses. At the same time factories on the new system were commenced in Wurtemburg, Prussia and Bavaria.

It seems impossible for a human affair to have been conducted in a more infallible way.

We were first informed of some of the leading facts in relation to this subject by *David Turnbull*, Esq., of Paris, in May 1837. At that time we had completed the examination of the beet sugar business in France, and were about to return to the United States. Struck, however, with the self-evident advantage of operating upon *pulverized* instead of *sliced* or *grated* beets, we determined to investigate the subject on the spot. Our visit to Germany for this purpose was in part fruitless, as has already been stated. But we were enabled to collect from the conversation of Mr. Schuzenbach, and from other sources, facts by which we became fully persuaded that his discoveries would impart to the beet sugar industry a new capacity of contributing to the prosperity, comfort and improvement of the northern inhabitants of the Old World and the New. Our experience, probably with processes and machines inferior to his, has been sufficient to confirm us in this persuasion.

We may now take it for granted that from beets of the right sort properly cultivated, 7 to 8 per cent of good crystalized sugar, fit for immediate consumption, and probably equal in appearance and value to the Havana white or clayed sugar, may be obtained, and this at an expense not exceeding 4 *cents* a pound. With these data let us consider the capacity of the beet to compete with the cane.

In the first place we find this great fact in the case, that the Louisiana sugar planters with $45,000,000 employed in their establishments produce but about *half* as much sugar as the French beet-sugar makers, with a capital of only $28,000,000, and getting but little more than half the sugar in the beet! Even these numbers are more favorable to the cane sugar than the truth will bear, because the amount of Louisiana capital is taken from a document of Congress, published in 1831, whereas, that of the French is taken from documents of 1837; and it is also exclusive of current expenses, while the French amount includes their whole capital fixed and floating The quantity of sugar produced in Louisiana in 1836–7 was 52,000,000 lbs.; of beet sugar in France, same year 107,905,785 lbs.

Mr. Thomas Spalding, of Sapelo island, in the State of Georgia, addressed in 1830 several papers to the southern cultivators, and at the request of the Secretary of the Treasury, to the federal government, on the sugar culture. This citizen holds the following language in relation to beet sugar.*

"I think that although at particular times and under particular circumstances, sugar, like rice and cotton, may be introduced from Bengal in injurious rivalship with the products of the United States, yet, if our public councils *are preserved from the pollution of monopolists*, and if the heart of the American farmer is left to go on in union with the head and hand, there is no difficulty or rivalry in his way, that his enterprise and perseverance will not overcome.

"Before we arrive at this conclusion, however, under existing circumstances, we should take into our deliberation, what the growers of sugar cane may have to apprehend from the manufacture of sugar from beet root; and it so happens that if the light of experience is of any value, the light of past experience will assist our inquiry.

"The saccharine properties of beets began to attract attention about the time that St. Domingo, the greatest sugar colony belonging to Europe, was convulsed with insurrection. Louisiana, a neglected province of Spain, was acquired by the United States just when Bonaparte, abandoning the hope of foreign colonies, determined that France should produce within herself all that France might require. His mighty mind was directed to this end. Sugar had been considered for centuries in Europe by old and young, by rich and poor, a necessary of life. He drew the attention of the French to the manufacture of sugar from beets, with zeal and power. Count Chaptal brought all his science to the labor. Marshal Marmont (the Duke of Ragusa,) with many other distinguished favorites, brought all their wealth to the enterprise: many books were written. Well, the result, after twenty years of effort, is, that France produced, in the last statements I have received, 5,000,000 pounds brown sugar, which cost a franc, or 20 cents, per pound.

"Louisiana in the same year, produced for export 87,000 hogsheads, equal to 100,000,000 lbs., at about 6½ cents per pound. Do we require any other evidence to put down apprehension upon this subject? If we do, these French books, in my mind, would furnish it. A detailed list of the manufactories of beet sugar has been published in 1829; and after reducing their weights and measures to our scale, it would appear to give something like a mean product of 360 lbs. to the acre of beets. Now agriculturalists know that root crops require deep preparations, are troublesome to sow, are troublesome to harvest, and still more troublesome to preserve, than the other products of the soil.

"But again the beet juice gives but 3½ per cent of sweets, while the cane juice affords at least 10 per cent. The beet juice requires for its

* Doc. No. 62, 21st Congress, 2d ses., Ho. of Reps., p. 39.

preservation and preparation for the kettle a heavy expenditure for sulphuric acid and animal charcoal, neither of which are necessary or advantageous to the juices of the sugar cane. We owe the introduction of the hydrometer and thermometer in the manufactory of raw sugar to the French chemists, but there our obligations end."

According to Chaptal's account published in 1822, which we have already mentioned, he obtained 803 *lbs. of sugar to the acre*; the Duke of Ragusa, (who had no factory while Bonaparte was on the throne or alive,) 825 lbs., and Crespel 1003 lbs. Taking the lowest production here mentioned we convict Mr. Spalding of an error of 443 lbs. to the acre, or nearly $\frac{3}{5}$ of the whole product. Again, he states that "the beet juice yields but $3\frac{1}{2}$ per cent of sweets, while the cane affords 10 per cent at least." Here is an error of 7, *i. e.* just $\frac{2}{3}$, the beet in fact containing $10\frac{1}{2}$ per cent of sweets. It is not necessary to specify all the minor errors which Mr. Spalding has fallen into in this statement. We quote him that the reader may know what a cane planter says upon this subject.

The average produce of the acre of beets in France is 30,000 lbs., and it has been about 26,000 lbs. at *Northampton*. Five per cent on this is 1300 lbs., the quantity of sugar which may be safely calculated on from every acre of beets. *Mr. Crespel* states his product in sugar to be 1500 lbs. to the acre.

In the United States, according to the statement of the *Central Committee of the Sugar Planters of Louisiana*, the quantity of cane sugar obtained from an acre, is 800 to 1000 lbs. under the most favorable circumstances.* The Agricultural Society of Baton Rouge did, however, qualify this statement as follows:—

"But sugar cane, on account of its numerous roots, and its strong vegetating power, soon wears out the richest soil. Even our alluvial lands on the banks of the Mississippi, inferior, perhaps, to none in the world, and planted for nearly twenty years past with cane, are nearly worn out. When, moreover, we recollect the misfortune of unfavorable seasons, it will be immediately perceived that much remains to be deducted from this calculation of 1000 lbs. of sugar to the acre. It has been proved above that the mean annual produce of three and five years amounted to but 6 per cent, or 600 lbs. of sugar to every acre."

* Doc. No. 62, as above, pp. 6. 24. 35.

In point of productiveness, therefore, the beet has 100 per cent the advantage over the cane in the United States; and this without supposing that any of the improvements upon the old French methods of manufacture will ultimately prove available.

But suppose that 7 or 8 per cent is obtained from the beet by the method of dessication, or by some of the improved French or Russian methods of maceration, how will the comparison then stand? The acre of beets will give 1800 to 2000 lbs. of sugar, just thrice as much as an acre of cane.

In the southern States they make one hand cultivate 5 acres. This is the general rate of tasking the laborer on the sugar plantations. The more humane and enlightened of the Louisianians consider 4 acres as fully sufficient to employ one hand. It is, however, well known that the slaves on the southern sugar plantations are constantly overtasked. They have always been so in the British and French West Indies, in the former of which 1 acre, and in the latter 1½, are all that a slave was ever required to till and tend. In Louisiana they cultivate less by hand than in the West Indies. We suppose that in all cases the severest overworking is in the manufacture of the sugar, not in the cultivation of the plant. Hear Mr. Spalding, who had been twenty years engaged in sugar planting, and professes to be acquainted with the system in Louisiana.*

"I conceive the negroes of Louisiana are too severely worked. There are too many *men* upon their plantations, and so far as I know they were declining in numbers and sinking in strength; but this arose in a great measure from the necessities of the planter, who is active and energetic; and in general no more spares himself than he does his slave. It was certainly not because sugar cane was the crop, but because the planter had, perhaps, in the beginning, been mistaken in his means, and was making manly efforts to relieve himself.

"When the culture of cane is confined to two acres of land to the hand, with some accompanying crop, the negroes unquestionably prefer it to any other culture in the country. They appear to me, so far as I can judge from my own, *to enjoy more health and to multiply faster* than they did before I introduced sugar cane among them; and this is reasonable, for every man, woman and child upon the plantation is feeding upon the sweets of the cane for three months of the year."

* Doc. 62, as above, p. 46.

There can then be no doubt that 5 acres of cane is too much for one hand, and that the labor of the sugar slave in the field, can only be deemed reasonable, because it is less unreasonable than his labor in the mill.

Now let us inquire how much land one hand can cultivate with beets. In France they allow 30 day's work to an acre, 24 of which are days of women and children, and the weeding is mostly done by hand and the hand hoe. In the United States, so far as we have had experience, it has taken from 12 to 16 day's work to cultivate an acre of beets, according as the land was more or less weedy. This did not include ploughing, harrowing and carting manure, for all which we add 3 days, making the whole number 15 to 19 days.

The growth of the cane requires 9 months, that of the beet 3 to 4 months. The working days in 9 months are 232, in 4 months 103; 103 divided by 17, the medium number of days required for an acre of beets, gives 6 acres and a fraction over, as the extent which one man with proper implements and a horse can cultivate with beets; 1 acre more than a man, though closely driven, can cultivate with sugar canes in $2\frac{1}{4}$ times as many days! In other words the culture of the cane costs $2\frac{2}{3}$ times as much as the beet. If we add to this fact the other, that only half as much product in sugar is obtained from an acre of canes, as from an acre of beets, the difference in favor of the latter, so far as culture is concerned, will appear enormous.

But it does not end here. The beet culture deepens and loosens the soil; the cane by its numerous and spreading roots, (it belonging to the family of *grasses,)* binds and stiffens the soil, leaving it always in a bad state for a succeeding crop. The cane field requires fallowing, or rest, two years for every two of bearing, the beet not only requires no fallows, *but is itself a substitute for fallows*, and saves the necessity of them for other crops. The cane exhausts, the beet fertilizes the land. The cane affords no manure except the tops and blades left on the ground; the beet, besides leaves and tops, multiplies the barn manure in an extraordinary manner. Finally, the beet feeds and fattens multitudes of cattle, sheep and swine, while the cane affords nothing for such a purpose.

We have already stated that the capital invested in the beet sugar business in France in 1837, was only ⅔ as much as was invested in the cane sugar business in Louisiana in 1829,* and that the quantity of beet sugar made in France in 1836—7, was 107,000,000 lbs,† while that of cane sugar made in Louisiana in 1829, upon ⅓ more capital was 45,000,000 lbs.‡ 1829 was reckoned a bad year in Louisiana, and we will take the preceding, which was the best ever known in that country up to 1829, the latest of which we have been able to obtain authentic returns. In that year the quantity of sugar made in that State was 80,000,000 lbs. This crop was called by the planters "abundant and extraordinary." But what was the extent of land cultivated to obtain this sugar? At that time there were 700 sugar plantations in Louisiana, averaging 487 acres of cane field each, making an aggregate of 340,900 acres. Of this 154,727 acres was actually bearing sugar canes. The remainder 186,173 acres were at rest, or planted with corn and beans for subsistence of the slaves.§

The extent of land cultivated with beets in France in 1836, was 61,750 acres,|| being ⅖ less land and producing nearly ⅓ more sugar, than the cane fields of Louisiana, without naming that portion of the latter, which lies fallow, or is cultivated as merely subsidiary to the sugar crop.

We have no account of the cost of manufacturing cane sugar, separate from the culture. We only know that the planters of Louisiana and Georgia have solemnly declared the whole cost to be 5½ *to* 6 *cts.* a pound, allowing only 6 per cent interest for capital and wear and tear of machines

* Summary of the Question of an Excise on Beet Sugar, by the manufacturers of Beet Sugar in the Arrondissement of Dunkirk, 1837. Letter of Phillip Hicky, in the name of the Agricultural Society of Baton Rouge, to Hon. H. H. Gurley, Doc. No. 62, as above, p. 35.

† Doc. No. 200, French Chamber of Deputies, 1837, p. 55, Table A.

‡ Doc. No. 62, as above, p. 49.

§ Doc. 62, as above, pp. 9, 10, 31.

|| Debate in French Chamber of Deputies, May 22, 1837. Bulletin of Sugars, No. 6, p. 100. Summary of the Question of an Excise, as above, p. 8.

and utensils, and only $25 a year for clothing and subsistence, to the laborer without wages.

In the British and French West Indies it costs 4⅔ *cents;* but it is said that in Cuba and Porto Rico, the planters pretend that they can make it at a cost of 3 cents and even 2½. This must be if it be at all, by very hard driving. We do not think that sugar will ever arrive in the United States at a cost of less than 4 cents a pound, to which must be added such duties as Congress may lay for revenue. With such conditions beet sugar in the United States need not fear competition from any quarter.

The production of sugar is said to be increasing rapidly in British India and Java; and the British government, in opening the English market to Bengal sugar, have shown a wise forecast in respect to the possible reduction of the cane products in the West Indies. It is not probable that the freedmen of the British West Indies, any more than of St. Domingo, will all pursue that species of labor, which is marked by memories of their severest hardships and deprivations. They will, probably, as soon as they can obtain small farms, occupy themselves to an increasing extent in raising provisions. But even if there should be no change of employment with them, the production of sugar would probably decline apace. The history of the cane sugar culture and manufacture warrants this conclusion. The business has successively disappeared from Sicily, Cyprus, Rhodes, Candia, the Canaries, St. Thomas, and Madeira, and for some time it has scarcely been sustained in many of the oldest islands of the West Indies.

The sugar of the East Indies is manufactured at a cost of 1 to 1½ cents a pound. This low rate is owing to the low wages of labor, viz. 6 *cents* per day. But after paying commissions, insurance, and freight, it can never come to us from that quarter at less than 4 or 4½ *cents* a pound, exclusive of the duties levied upon it here.

If, therefore, beet sugar can be made in the United States at a cost of 4 *cents* a pound, it will be "secure in its existence," and may smile at the efforts of any competitor, though backed by the cheap hosts of Hindostan.

As a natural consequence of the cheapness of the article, the consumption will be vastly increased. Instead of 14 to 16 lbs. to an inhabitant, it will be 30 lbs. at least, and for the whole United States, 500,000,000 lbs. per annum; and the general improvement in agricultural and mechanical skill and prosperity will be advanced in an equal ratio.

The cane planters reckon among their expenses, "decreased value," "risk," "loss," "death," and "deterioration," of slaves. This they set down at 5 *per cent.** This will be understood by a reference to Mr. Spalding.†

"It would take 50 laborers to take off 100 acres of cane in the two months of November and December, and to grind and manufacture it. In Louisiana the same number of hands would cultivate 250 acres, of which however 100 would be ratoon cane."

Mr. Spalding may be considered a credible witness on this point, from his intimate acquaintance with the subject, and his situation at an impartial distance from the practice upon which he comments. His judgment is in a good degree confirmed by the Central Committee of the sugar planters of the State of Louisiana.‡

"Sixty working hands are necessary to cultivate 240 acres of cane, planted in well prepared land, and to do all the work necessary until the sugar is made and delivered."

But in point of fact the number of working hands is 50 to 250 acres as Mr. Spalding states. Indeed it is rather short of this.§ But taking Mr. Spalding's statement, we have 10 less hands and 10 more acres of canes than the Central Committee think sufficient and proper; *i. e.* 5 *acres* to one hand instead of 4 *acres.* It is the last ounce that breaks the camel's back. By the tables accompanying

* Letter of the Central Committee of the Sugar Planters of the State of Louisiana to Hon. S. D. Ingham, Sec. 7, of Treas. Doc. No. 62, as above pp. 9, 11.

Letter of the Agricultural Society of the Parish of St. James; Doc. 62, as above, p. 16.

† Letter of Thomas Spaulding to the Editor of the Southern Agriculturist, Dec. No. 62, as above, p. 46.

‡ Answer of the Central Committee to S. D. Ingham, July 1, 1830; Doc. 32, as above, p. 7.

§ Id. ib. pp. 8, 9.

the letter of the Central Committee, we learn that on 29 sugar plantations in the Parish of Plaquemine, in the State of Louisiana, a fraction over 5 *acres* is cultivated by each working hand; but that on some of those plantations it is more than this. For example; on the plantation of *G. B. Milligan*, *Joseph Saul*, *Charles Reggio*, and *John J. Coiron*, members of the Central Committee; it is 5¼ *acres*. On the plantations of *Felix Forestall*, *Villere & Lavergne*, and *Dupuy & Lethiec*, it is 6¼ *acres*; on those of *F. Delery*, *Fazende & Villere* and *Augustus Dupré*, it is 7¼ acres, on those of *Simon Girod and Arnault Laneaux*, is 9½ *acres* to a hand. Of the 29 plantations there are but 5 where the number of acres to the hand is as low as the Committee deem proper, and only 3 where it is as low as Mr. Spalding deems so. The whole number of slaves upon these 29 plantations is 2089, worth at $500, the estimate of the planters, $1,044,500. On the 700 sugar plantations then existing in Louisiana, the slaves at the same rate would be in number 50,400; and in value, $25,200,000. 5 *per cent* of the slaves is 2520, and 5 *per cent* of their value is $1,260,000.

But this is not the whole extent of the loss. These slaves ought to increase, according to the general rate of increase of free colored persons in the United States, nearly 4 *per cent* per annum; and according to the average increase of slaves 3 3/10 *per cent.* More than this the slaves on sugar plantations ought to multiply; * but we will call it less, viz. 3 *per cent.* We thus have a further loss of 1512 slaves, and $756,000. Adding this to the 5 per cent as above, we have a loss on the sugar plantations of Louisiana to the amount of 4032 hands, and $2,016,000 per annum, over and above the natural infirmities and deaths.

From this important item of expenditure the manufacturers of beet sugar will be exempt.

Another of their advantages will be the superior grain

* Doc. 62, as above, p. 46.

and purity of beet sugar, and its higher value with refiners and confectioners; and in all probability with domestic consumers also. The Louisiana sugar, when refined, yields but 30 to 35 per cent.* *Mr. Louis Say*, a scientific refiner of Paris, informed us that from beet sugar he constantly obtains,

Loaf sugar	. . .	50 lbs.
Lump "	. . . .	$16\frac{2}{3}$ "
Bastard "	. . . . .	$8\frac{1}{3}$ "
Vergoise "	. . . . .	$8\frac{1}{3}$ "
Molasses "	. . . . .	$16\frac{2}{3}$ "
Total	. .	100 "

The quantity of loaf sugar yielded by the beet more than cane is, therefore, from 15 to 20 per cent, and probably in the same proportion for the inferior qualities of lump, &c.; and its superiority over the West India sugars is, in this respect, 5 per cent.

The beet is one of the surest crops cultivated in the United States, and the cane one of the most uncertain. We have seen that the crop of Louisiana, from 80,000,000 lbs., which it was in 1828, fell off to 45,000,000 lbs. in 1829. In the year 1835, there was exported from Louisiana, coastwise, 43,000,000 lbs. Supposing that an equal quantity went up the river, which we are informed is usually the fact, the whole crop was 86,000,000 lbs. In 1836, it was by the same estimate only 11,000,000 lbs.† The causes of these great fluctuations are bad seasons and early frosts. This will be better comprehended by quoting individual cases.‡

* "In 1829 the sugar crops of Louisiana amounted to one-third, or a little more than a third, of those of 1828—a fact, the truth of which you may have ascertained, sir, by comparing two statements of the produce of the years 1828 and 1829, drawn by Mr. P. A. Degelos, of New Orleans, which have been published, and with which you are, no doubt,

* Agricultural Society of Baton Rouge to Hon. S. D. Ingham, Sec'y Treas., Sept. 26, 1829. Doc. No. 62, as above, p. 27.

† Annual Statement of the N. Orleans Price Current, Oct. 1, 1839.

‡ Letter of Agricultural Society of Baton Rouge, Doc. 62, as above, pp. 19, 20.

fully acquainted. From these statements, it appears, that, in the year 1829, the produce of the parish of St. John the Baptist, situated on the left side of the river, amounted only to 1,948 hogsheads, instead of 4,453, its quantity in 1828; that St. Charles, on the same side of the river, made, in 1829, 2,925, instead of the 7,446 of 1828; and that the parish of Jefferson, on the left bank of the Mississippi, produced in the year 1829 only 1,840 hogsheads, while, in 1828, it had made 6,096. The same proportionate decrease will be found to prevail, sir, in most of the other parishes, or on a majority of the plantations; the crop of Mr. Joseph Sauniac, for instance, which in 1828 amounted to 920 hogsheads, dwindled in 1829 to 265; and finally, the better to contrast the unfavorable statement of the crops of 1829 with the happiest result of 1828, we see, from the same schedule of Mr. Degelos, (a very correct work, and one truly deserving of recommendation as a statistical sketch,) that Mr. Woodward, of the parish of Iberville, who in 1828 had made 117 hogsheads, in 1829 made only 6; and that the crop of Mr. Barker, residing in the parish of St. John the Baptist, instead of 330, his produce in 1828, amounted to 12; results truly deplorable, and in reality to be reckoned as nought.

On the other hand the sugar manufactured in France has invariably increased from year to year, unless it has fallen off in 1838–9, of which we have not yet the returns.

1832–3	it	was	22,000,000	lbs.
1833–4	"	"	33,000,000	"
1834–5	"	"	44,000,000	"
1835–6	"	"	66,000,000	"
1836–7	"	"	107,000,000	"
1837–8	"	"	112,000,000	"

The cause of the increase of 1837–8 being less than before, was probably the laying of the excise in that year.

The beet will grow very tolerably on poor land, and will in time make it good; the cane demands rich land, and will make it poor.

The region of the cane has been constantly contracting, and has never been enlarged except by taking possession of new islands and continents; it makes every other production subordinate to itself, or drives it from the field. The beet extends its dominion by reclaiming and fertilizing waste and fallow lands, and it harmonizes with, and greatly helps every other farming production.

It is supposed that the soil of the West is peculiarly adapted to the beet. We have no doubt of the fact, and that the beet sugar, as a manufacturing concern, will be more profitable there for sometime than in any other portion of the country, partly from the distance of the great markets, and partly from the cheapness of land and fuel. But we doubt whether any part of our territory is destined to be more benefited by it, than the New England and other States, which have hard and poor lands, and a *lack of manure*. In the West, as we are informed, manure is not an object of importance to the farmer, except as creating a nuisance, and causing expense and trouble to move it out of the way. Nay, we have heard that farmers in that region often abandon their log barns, and build new ones rather than remove the manure to the gulleys. But in New England manure is the life and soul of agriculture. If the beet sugar business can boast of any advantage more particularly preëminent, it is the multiplication and improvement of live stock and manure. This will be in a great measure lost upon the West, while it will be precious beyond calculation to the North, and very valuable to some portions of the South.

Note. On reviewing our work we find that two apparatuses, the "Kiln of columns," p. 81, and the "macerator," p. 87, have not been credited to their able and useful inventors, *Messrs. Martin & Champannois, Machinists and Engineers, of Arras.*

APPENDIX.

Extract from the Report of the "Second Exhibition of the Massachusetts Charitable Mechanic Association," 1839.

"D. L. Child, *Northampton.* Beet-Root Sugar — crude and refined. Manufactured by the improved process of Schuzenbach. The crude or raw sugar is well made, dry, and of good grain. The refined shows that this article can be made of as good quality as sugar from the cane. Of the extent of the manufacture by the exhibiter, the Committee are not informed. *A Silver Medal.*"

Premium of the Massachusetts Agricultural Society, 1839.

"To the person, persons, or corporation, who shall manufacture from the Sugar Beet, Sugar in the greatest quantity and of the best quality in the year 1839; giving a full and particular account of the process of manufacturing it,

A premium of $100."

This premium was awarded on the 5th of December 1839, to the "*Northampton Beet Sugar Company.*"

Extract from a Letter of Hon. Levi Lincoln, *President of the Worcester County Agricultural Society.*

"Worcester, Nov. 13, 1839.

"Pursuant to your instructions, I have forwarded to your address and the care of Ellis Gray Loring, Esq., the box of sugar, which was intended for exhibition at our Cattle Show, but unfortunately was not seasonably received. Availing of your kind permission, samples of the sugar were submitted to the inspection of several gentlemen.

The *brown* sugar was found to be pure, very sweet, and entirely free from any bad taste, and its quality, *in every respect*, was highly satisfactory. The refined or lump sugar, seemed not so well granulated as is desirable. Still we are well satisfied, that as an experiment in the manufacture, it is highly encouraging, and we all felt that the country was largely indebted to your intelligence and enterprise, in demonstrating, beyond all question, how entirely this application of domestic industry is at her command. I scarce need add, that your treatise on the subject will be looked for with much interest.

From MARTIAL DUROY, *Confectioner.*

D. L. CHILD, Esq :—

Dear Sir,—Knowing the interest you take in all that refers to Beet Sugar, and thinking you might like to know how your beet sugar stands a high degree of concentration, I take this opportunity to communicate to you the result of my experience, confident that if my suggestions are not new, you will at least excuse the motive that prompted them.

Having, while in France, heard the confectioners, in general, deprecate the use of beet sugar in their work, I was naturally a little prejudiced against it, when I was called on by you to make some confectionary for the Ladies' Anti-Slavery Fair. I was pleased to find upon trial, that your raw beet sugar was extremely easy to clarify, and that it grained freely. These attributes of good and pure sugar, reconciled me at once with it; and I made a variety of confectionary as easily and as handsome, as with the best Havana. But its power of crystalization is particularly interesting, as it is upon this that depends its successful transformation into loaf sugar; and as far as a pretty considerable experience goes to establish it, I think beet sugar obtained by your process does crystalize both easily and abundantly, forming, at will, coarse or fine grains peculiarly brilliant, and giving by far a smaller quantity of molasses in the process of refining than cane sugar of a corresponding quality. I found also, this molasses of a pleasant taste and well adapted in its chemical composition to culinary purposes.

Accept, Sir, my best wishes for your success in the noble enterprise you have enlisted in, while I subscribe myself, Sir,

Your very ob't servant,

MARTIAL DUROY.

Boston, Nov. 1839.

Extract from Baring, Brothers & Co's. Prices Current, London, January 26, 1839.

"The advices from St. Petersburg are unfavorable, the deliveries having fallen off, partly owing to the increase of smuggling, and partly to the extending cultivation of Beet-root. It appears, by some recent reports, that in France the manufacture of Sugar from Beet-root the past year has reached 50,000 Tons in that kingdom; these facts should make our friends cautious as to entering into speculations in White Havana, at high prices."

Extract from the same, March 22, 1839.

"The continued unsatisfactory accounts of the disinclination of the negroes in the West India Islands to work under the new system, gives serious grounds for apprehending a very great deficiency in the crops there. This has caused a material advance in the prices of West India, Mauritius, and Bengal kinds, particularly on the low qualities, which may be quoted fully 6s per Cwt. dearer. From St. Petersburg the advices are flat."

Extract from the St. Petersburg Prices Current, July 24, 1838.

"The increasing success of the Beet-root Sugar Establishments in the interior, would for the present seem more than adequate to meet any supposed augmentation in the general consumption of raw Sugars, without any addition to the supply received from abroad."

Extract from the London Mechanics Magazine, Aug. 1836.

"MANUFACTURE OF BEET-ROOT SUGAR IN RUSSIA.

"Sir,—The manufacture of Beet-root into sugar in the Russian empire has of late become very extensive; there are already no less than twenty-five large establishments for this purpose in different parts. Thinking that the following account of one of the principal of these establishments, viz. Micharlofsky Sugar-works in the government of Tula, the property of Count Bobrinsky, may be interesting to the English public, I send it for insertion in your widely circulated Journal:—

The quantity of beet worked in the year 1835 was 200,000 poods, equal to 85,357 cwt. 0 qr. 16 lbs.; the sugar produced from it, 15,600 poods, equal to 5014 cwt. 1 qr. 4 lbs.

Price of a pood of beet	15 copecks.
Expense in working do.	35 do.
	50

Produce of one pood of beet $2\frac{2}{5}$ lbs. of raw sugar at 1 ro. 10 co. per pound.

The number of men employed 250.

The quantity of land required to produce the beet 350 deciatines, equal to 945 acres.

The beet is generally taken from the peasantry instead of the obrok or fine, they as serfs, have to pay their baron.

The proprietor of this manufactory is an accomplished nobleman; his experiment in this case has been highly successful.

One great evil is the impossibility hitherto experienced of keeping the roots any length of time, which makes it expedient they should be worked as soon as possible after they are taken from the ground.

I have been favored with a specimen of raw and refined sugar from these works, of which I send you a small sample, and am only sorry the distance does not allow me to send a a larger one.

The Russian lb. is equal to 14¼ oz. English; a pood 40 lbs. Russia, equal to 36 lbs. English; a rouble, equal to 100 copecks; stirling value 10½d.

Your constant reader,

J. K.

Petersburg, June 25, 1836.

[The samples sent are excellent; the raw sugar not quite so good as that from the cane, but the refined equal to the products of our refineries.—Ed. M. M.]

Extract from the Philadelphia National Gazette, Sept. 1839.

" The States, composing the German Customs Union, possessed, towards the close of 1838, eighty-seven manufactories of Beet-root sugar in full operation, viz. Prussia, 66; Bavaria, 5; Wurtemberg, 3; Darmstadt, 1; other States, 15; besides 66 which were then constructing.

IMPORTS OF SUGAR AT BOSTON.

CUSTOM HOUSE, *Boston*, *December* 19, 1839.

DEAR SIR, — In reply to your note, I have caused to be prepared the following Abstract of the quantity of Imports of Sugar. The Duty on White Sugar is about 2 3-4 to 3 1-4 cents, varying with the cost, and the average Duty on Brown about 2 cents. Of Loaf Sugars there have been no Imports for many years. The countries are designated. Cargoes coming from Siam, included under Asia generally.

Respectfully, your obedient servant,

GEORGE BANCROFT.

DAVID LEE CHILD, Esq.

WHENCE IMPORTED.	1834.		1835.		1836.		1837.		1838.	
	Pounds White.	Pounds Brown.	Pounds White.	Pounds Brown.	Pounds White.	Pounds Brown.	Pounds White.	Pounds Brown.	Pounds White.	Pounds Brown.
Danish West Indies,				233.098		155.873		135.540		55.860
Dutch West Indies,		460.279		18.199		12.857		1.960		3.940
Dutch East Indies,		93.984		26.036		8.114.760		4.164.570		2.144.940
British West Indies,		26.485	784	22.791		52.350		55.990		820
British Am. Colonies,		43.142	5.809	5.172		24.726			2.088	
Manilla,		160.125		3.051.030		6.057.772		9.137.376		3.535.000
Cuba,	1.097.080	10.416.000	2.869.049	13.112.046	3.369.032	13.548.360	7.220.056	10.716.480	7.539.315	15.416.520
Other Spanish W. In.		2.276.105		2.638.066		2.300.514		2.373.390		2.493.760
China,			856		2.148	61.940	744	24.524		200
Asia generally,						722.413		324.940		197.597
Brazil,		374.179	235	3.812.576		5.636.634		407.460		2.156.670
Hayti,		1.085				1.020				820
Colombia,						58.944		45.740		737.020
British East Indies,			4.595			1.350 727		671.400		393
Total,	1.097.080	13.851.384	2.881.328	23.394.264	3.371.180	38.099.880	7.220.800	28.161.370	7.541.403	26.743.540

Imports of Sugar into the United States during 5 years, beginning Oct. 1, 1833, and ending Oct. 1, 1838, together with the annual cost thereof, and the price per pound, at which it was purchased in the foreign market.

	Pounds Brown.	Dollars.	Pr. p. lb. Cents.	Pounds White.	Dollars.	Pr. p. lb. Cents.
1834	107.483.841	5 027.377	4, 6	7.906.014	510.452	6, 4
1835	111 806.880	5.751 074	5, 1	11.229.359	1.055.100	9, 3
1836	181.243.537	11 623.699	6, 4	10 132.578	890.805	8, 7
1837	120.416.071	6.118.166	5	15.723.740	1 084.502	6, 8
1838	139.200 905	6.466.199	4, 6	14.678.238	1.120.161	7, 6

Imports of Molasses during the same period.

	Gallons.	Dollars.	Cents
1834	17.086.472	2.989 020	17, 4
1835	18.971.603	3.074.172	16, 2
1836	18.051.784	4.077.312	22, 5
1837	16.451.182	3 444.701	21
1838	21.196.411	3.865.285	18, 2

Estimated quantity of Sugar and Molasses produced in Louisiana in 5 years, commencing Oct. 1, 1834, and ending Oct. 1, 1839.

	lbs. Sugar.	gals. Molasses.
1835	86.983.300	4.349.165
1836	22.502.450	1.125.122
1837	63.024.850	3.151.242
1838	60 281 300	3.014.065
1839	65 914.550	3.295.727

The average import of Sugar for the last five years has been 144,000,000 lbs. per annum; the average production of Louisiana 60,000,000 lbs., and the average export 20,000,000 lbs., leaving for the annual consumption of the United States, without taking into the account maple sugar, nor the products of the sugar mills in *Florida*, *Arkansas*, *Mississippi*, *Alabama*, and *Georgia*, 184,000,000 lbs., which it would take 920 beet sugar mills, working at the average rate of those in Europe, to make.

The average import of Molasses for the same period has been upwards of 18,000,000 gallons, the production in Louisiana nearly 3,000,000 gallons, and the export trifling; consequently the annual consumption of molasses in the United States, omitting maple, is 21,000,000 gallons.

N. B. The discrepancy of the quantities stated pp. 144 and 151, are caused by omitting in the first estimate the domestic consumption of Louisiana. In the last estimate we have added the supposed domestic consumption of that State to the export, and doubled that sum to get the whole production of sugar in the State and vicinity.

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